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Increased Appropriations for Mine Experiment Stations

NO ONE in the mining industry seriously questions the desirability of expanding the activities of the U. S. Bureau of Mines, particularly in connection with technical experiment and research. Not only the mining industry but the public at large will benefit as a consequence of an increase in the scope of this work. Obviously, such an increase will entail greater appropriations from the federal government than have been made heretofore.

Assuming that the appropriations are to be forthcoming, the problem arises of determining how they can be spent to give maximum effective result. It is possible that if a fresh start were made, three or four cities strategically situated—say, Pittsburgh, Minneapolis, St. Louis, and Salt Lake City—might be selected for the establishment of experiment stations. Field offices similar to those now in existence, but more numerous, could serve as headquarters for engineers whose function it would be to keep in close contact with actual mining operations, and guide the activities of the experiment stations to meet the needs of the industry.

However, eleven experiment stations now exist, scattered over the country; they are "going concerns," performing a useful function. Each has its friends and supporters in the industry and in Congress. There is little likelihood that any of these can be abolished without arousing vigorous opposition. Any program of reorganization involving such a provision, or that contemplated the curtailment of activities at any station, would be difficult to put into effect.

Still, assuming that funds are available for expansion, two questions arise: (1) Is it better to spread the money equally among eleven stations, improving each to a limited extent; or to concentrate the major portion of the money in a few stations with a view of making them large, well equipped and well staffed? (2) If the latter policy is considered the better, what stations should be selected for the major expansion?

To the first question an unbiased observer doubtless would answer that the second alternative would produce the best results. The executive of a large private corporation, faced with the same problem, would decide on concentration of money and effort. Duplication of buildings, plant, and equipment would be avoided. Fewer highly competent engineers would be required; or, conversely, the average ability of the staff members would be higher. In all likelihood, more work of an effective character could be accomplished under the plan of having two major regional stations.

Finally, comes the question of locations. The Pittsburgh station already has become, in effect, a central station for the Eastern section of the United States. It is the largest station; it has the most elaborate laboratories and equipment, and the largest staff. Though it covers a wide range of subjects, the experimental work done at Pittsburgh deals largely with fuels—solid and liquid, and ferrous metallurgy. The obvious step to complement this service to the industry is the establishment of a central station for investigation and research in the mining, ore-dressing, and metallurgy of non-ferrous metals. The logical location would be in the Rocky Mountain region, in which are situated most of the mines that produce metals other than iron. The approximate geographical center of this area is Salt Lake City. Salt Lake Valley is the largest smelting center in the world, two copper and three lead smelters being situated within 25 miles of the city. No fewer than eight important concentrators and a score of mines come within the radius of a circle only slightly larger. Mine operators in the Coeur d'Alene district, in Idaho; in Butte and elsewhere in Montana; in Nevada, and in Colorado have easy access to Salt Lake. Arizona, New Mexico, and California are not far away. No other place compares with it from the standpoint of convenience to the great majority of mine operators all over the West.

Moreover, the present station at Salt Lake City has the most extensive plant for the investigation of ore-treatment problems that the Bureau possesses. The mine operators in Utah and the authorities of the Utah School of Mines—where the station is situated—co-operate actively with the Bureau in much of its work. Expansion of activities to meet the requirements of a large central station could be accomplished more economically at Salt Lake City than at any other place; and the results should be advantageous to all concerned.

In the coming Congress a bill is to be introduced providing for the expansion of the work at the Bureau's experiment stations as set forth in the foregoing. Concerted support from the mining industry will be needed, if the proposed legislation is to be passed. *Engineering and Mining Journal* feels that, even if local ambitions be side-tracked in some instances, this support should be forthcoming, as promising maximum benefit for the industry as a whole.

That Manganese Stockpile

THE SANEST PROPOSAL made with respect to manganese as an essential war mineral is that the government should create and maintain a stockpile of ore sufficient to meet its probable steel requirements in case a war should cut off imports of foreign ore. The size of the stockpile is problematical. Obviously, the tonnage should be sufficient to satisfy the government's needs until enough domestic reserves could be brought into production to take care of them. Under the conditions prevailing at

the moment, with the domestic manganese industry just beginning to develop, the stockpile would have to be large, for it is certain that many months would pass before the desired tonnage could possibly be produced from domestic sources.

Should the infant domestic manganese industry, now struggling to develop, be destroyed by the removal of the tariff, the proposed stockpile would have to be even larger, for then, in case of a stoppage of imports by war, complete revivification, and not simply stimulation, of the industry would be necessary.

The argument for a manganese stockpile has been presented in earlier issues of this publication—in those of April 30, July 30, and Sept. 24, 1927. The proposal that a stockpile be created was first advanced by the joint committee on war preparedness of the A.I.M.E. and the Mining and Metallurgical Society of America. This was several years ago. It was advocated publicly at Cleveland on April 20, 1927, by Mr. J. V. W. Reynders at the now historic manganese meeting. Recently—on April 5, 1928, to be exact—it was urged by Mr. C. M. Weld at the monthly meeting of the Mining and Metallurgical Society, a meeting devoted to the topic of manganese and at which Mr. Weld presided. The proceedings of this meeting were reported in the April 14 issue.

The proposal that a stockpile be established merits the serious consideration of Congress. We are sure that it has the unanimous support of the War and Navy departments. It must be considered entirely apart from the question of whether or not the tariff on manganese shall be permitted to remain. The stockpile should be established as a safeguard of national security. The tonnage suggested has been estimated at 600,000, to be accummulated in equal installments over a period of nine years.

As a matter of equity, the domestic production should be utilized for this purpose so far as it can meet specifications as to grade at the prevailing market price. Such a proposition is entirely fair and should be satisfactory to all. Such portion of each annual installment as cannot be supplied by domestic producers could properly be purchased abroad. Those interested in foreign mines will welcome this suggestion. The proposal in general, therefore, merits and should receive unanimous support.

Importance of the Slusher in Iron-Mining Operations

SELDOM has a machine had a more important influence on underground mining operations than the power-operated scraper or slusher, a typical installation of which is shown in the illustration on page 724 of this issue. It is not too much to say that in the iron mines of Michigan the slusher has been the outstanding factor in keeping the per-ton cost of production from climbing to unheard-of levels. Speaking generally, and taking into account bonus or contract earnings, the average remuneration of the miner today is about $5, compared with $2 prior to 1914. Against this may be set an increase in the average number of tons mined per underground worker, ranging from 15 to 18, compared with 6 or 8 fifteen years ago. The net result is that the labor cost of producing a ton of ore today is about the same as it was in the earlier era, when virtually every pound of rock was shoveled by hand into a car or directly into a chute. It is by no means certain that even present wages would attract the number of men needed today to move the ore by that method.

Two factors, among others, have contributed to the successful use of the slusher: the engineers of the mining companies have experimented systematically and persistently and have studied the design of the scraper itself; and the manufacturers of machinery have developed "engines"—operated by electricity or compressed air—that possess the necessary speed and flexibility and at the same time are sufficiently strong and durable to survive the rough usage that movable equipment underground always gets. Many may be surprised to learn how small variations in the angles and dimensions of a device as seemingly simple as a slusher affect the efficiency of performance. No less remarkable is the importance of detail in the design of the motor-hoist unit that controls the journeyings of the scraper.

Similar methods of handling broken ore are being used in various districts, but perhaps nowhere to better advantage than in the Michigan iron mines, in one of which was taken the photograph for the illustration mentioned. A well-informed engineer has expressed the opinion that, had it not been for the slusher, comparatively few of the underground iron mines would be in operation today.

Simplifying the Calendar

WITH the increased complexity of modern life and the competitive struggle that exists for supremacy if not for existence comes a tendency to avoid what is unnecessary and to simplify what is complicated. Many countries still operate under the handicap of an archaic system of weights and measures and will doubtless continue to do so until the engineer and the scientist take a hand in national reform movements. The simplification of currency denomination by the adoption of the metric system has saved the Americas many millions of dollars in useless labor and futile calculation, to say nothing of the advantage of mechanized computation and mathematical accuracy in result.

To Mr. George Eastman the world will owe a debt of gratitude for sponsoring a practicable scheme for the reform of the calendar, originally proposed by Mr. M. B. Cotsworth. The defects in the present system are obvious and acknowledged. The International Fixed Calendar will have 13 months, each of 28 days, with an eighth day "Year-Sunday" added to the last week in each year.

The simplified calendar has already met with wide acceptance, and the movement has disclosed, incidentally, that a large number of firms and organizations have been using the 28-day month for several years. The advantages of the substitute system are legion; the disadvantages, apparently none. However much any change from accustomed routine and age-long habit is unpopular in certain quarters, it should be recognized that the present calendar system is provocative of complication, unnecessary labor and avoidable waste, inhibiting a proper control and encouraging a condition that is detrimental to efficient production, scientific comparison and accountancy.

Eventually the change will be made. Why not now?

Engineering and Mining Journal is in wholehearted agreement with the proposal, and urges those of its readers who are interested to write for the information that is available for distribution from the offices of Mr. George Eastman, 343 State St., Rochester, N. Y.

Chilean Nitrate Industry Decides to Paddle Its Own Canoe

WORLD synthetic-nitrogen product manufacturers planned a conference de luxe that would be unique in its detachment and surroundings. The scheme materialized, and within the past week the North German Lloyd steamer "Lutzow" sailed from Venice for a leisurely cruise in the Adriatic, carrying representatives of the largest synthetic concerns in Europe and America. It is said that papers will be read and discussed, but rumor has it that the purpose of the jaunt was to make the world sit up and take synthetic products as and how prescribed by the promotors, and to come to an amicable arrangement about prices and territories.

Owing to propaganda on a comprehensive scale in recent years, the world has been taught to believe that the Chilean nitrate-mining industry was disorganized and doomed to early extinction. Only a few years ago this propaganda took the form of reiterated statements that the exhaustion of the deposits was in sight. The prophets have been confounded. After a slump caused by illogical marketing methods and an absurd system of price control, a reform movement has effected an economic transformation. Demand has increased so that the present nitrate year—ending June 30, 1928—will record sales of about 3,000,000 tons, exceeded only in 1916, 1917, and 1918, when so much nitrate was needed to win the war. Europe takes 47 per cent more this year than last; the United States, 55 per cent more. Prices have been steadily returning to normal since the decline that naturally followed the announcement of free sales in April, 1927; and, at the present quotation, general prosperity is assured. About 65 plants are in operation, almost all of which utilize a process, introduced in 1876, that is wasteful of labor and hopelessly inefficient as to technical result. Yet the industry is again on its feet, which shows that so much rich ore remains that a general technical revival is highly improbable in the immediate future.

The export tax of about $10 per ton still supplies the Chilean government with its major income requirement, which indicates that a trump card is being withheld for use in the event of serious competition. The government's attitude is entirely reasonable. Ample scope exists for price reduction by a frugal instead of a lavish expenditure for new plants, and by economical and efficient methods of mining and beneficiation.

Too late did the synthetic interests realize that Chilean nitrate could "stage a comeback"—that the product had superior qualities, that a keen demand existed, and that the natural fertilizer had no reason to fear the competition of its rivals. A belated invitation to Chile to participate in the libations and deliberations on board the "Lutzow," in furtherance of Germany's desire to enlist Chile as a partner rather than to face her as a competitor in the world nitrogen market, has elicited a courteous refusal.

Chile is "sitting pretty." The appointment of a distinguished German chemist as director of the Producers' research bureau a few years ago and the absence of technical progress in the majority of Chilean nitrate plants may not be unrelated circumstances. Frugality in capital expenditure, economy in operating expense, and efficiency in beneficiation are not immediately necessary, however much each reform may be clamored for. Synthetic-nitrogen products, on the other hand, are being manufactured by the utilization of a combination of scientific research, applied technology, and engineering skill unequaled in the history of industrial development; the progress made in taking advantage of all possible avenues of advance indicates that few major opportunities exist for technical improvement or material reduction in cost.

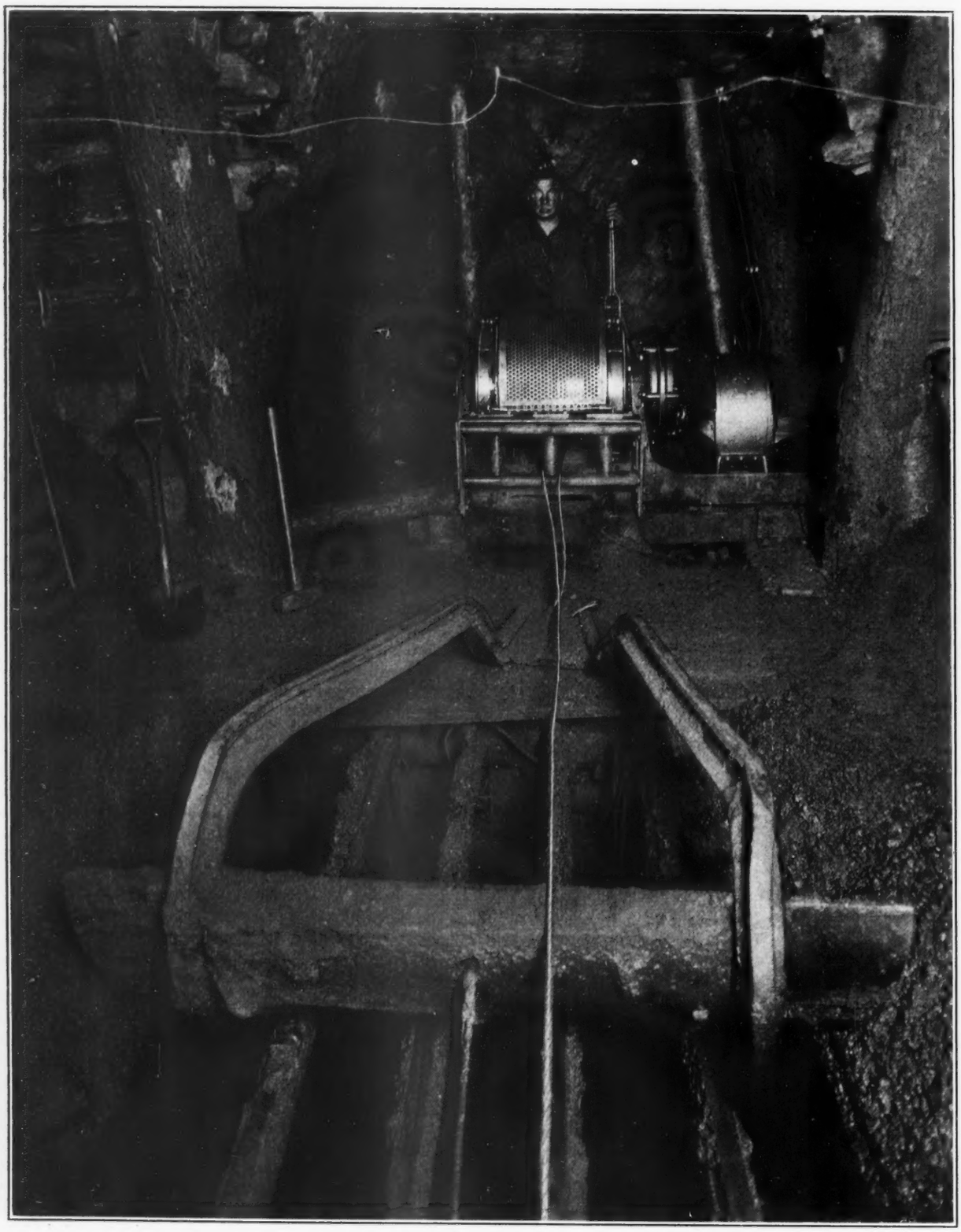
The Chilean nitrate mining industry, though backward technically, hampered by a heavy export tax and oppressive labor restrictions, is more than holding its own. It possesses so many trump cards in reserve that a compromise with its competitors at this stage would merely mean a forfeiture of income and a curtailment of opportunity.

Utilizing the Experience of the Mining Engineer

APROPOS of the lack of professional cooperation between engineers of various kinds, commented upon in an editorial on the St. Francis dam disaster in *E. & M. J.* of April 14, Mr. H. G. Moulton calls attention, on page 739, to the existence of a collection of data by the Committee on Ground Movement and Subsidence of the American Institute of Mining and Metallurgical Engineers that should prove useful in the study of dam foundations. This committee was organized six years ago under the chairmanship of Mr. Moulton, primarily to stimulate the publication of papers dealing with the behavior of earth and rock masses involved in caving methods of mining copper ores. The scope of the work gradually broadened, and many valuable papers have been published on various phases of the general subject. Such problems as the behavior of banks in open-cut mining and the reasons for several widely discussed landslides have come within the scope of the activities of the committee. Problems involved in ascertaining the best site for a dam are more than merely geological. The building of a big dam concentrates and brings into play forces and pressures of great magnitude; an examination of the probable effects of these "new" forces is a problem in earth dynamics, for the solution of which the mining engineer is better equipped than any other. The experience recorded in the publications sponsored by the Institute committee might well be utilized by the authorities who are investigating the causes of the recent disaster in California, and more particularly by builders of new dams.

In general, the knowledge and experience of the mining engineer are not used as much as they should be: though probably he himself is to blame. Skepticism was expressed in some quarters when it was decided several years ago to employ a mining engineer as consultant on subway construction in New York; but his advice saved the city tens of thousands of dollars. A mining engineer of outstanding qualifications ought to be a member of the board that selects the site for any important dam to be built in the future.

Slushing Iron Ore in Michigan



A double-drum Sullivan electric hoist operates this slusher, in the Sunday Lake mine at Wakefield. *See page 722*

The Harris Process of Lead Refining

Method and Equipment for Removing Arsenic, Tin, and Antimony from Lead Bullion and Alloys by Passage Through Molten Sodium Hydroxide, Chloride, and Nitrate

By R. WINTER
Metallurgical Engineer, London

THE Harris process for the purification of lead and the removal of constituents from lead alloys takes its name from the inventor, Henry Harris, of London, who took out the first of a series of patents in May, 1919. Plants are now in operation in the United States, Mexico, Great Britain, France, Belgium, Germany, Italy, and Spain. Not only is the Harris process an economic advance on previous methods, but it is also of great interest scientifically, representing a complete departure from the methods involved in furnace oxidation, and the adoption in a cyclical process of exact principles of chemical engineering combined with the use of an automatic self-contained machine for the metal treatment.

The process is applied to the purification of silver-lead bullion by the removal of arsenic, tin, and antimony prior to the elimination of silver by the Parkes process and to the subsequent refining or dezincification of the desilverized lead. It also has a wide field in the treatment of secondary or residual scrap leads. For instance, lead alloy containing arsenic, tin, and antimony can be converted into exceptionally pure antimonial lead by removal of arsenic and tin only. Further, an integral part of the process is the recovery of the impurities separate from one another in easily marketable form.

These results are obtained in two steps: The first embraces a dry treatment in which the molten impure metal is circulated through a molten mixture of sodium hydroxide and chloride. Impurities are oxidized and enter the reagent, through the action of atmospheric oxygen, accelerated, in the case of arsenic, tin, and antimony, by the gradual addition of sodium nitrate to the mixture. The lead itself is absolutely unaffected and is directly recovered in a particularly pure state. Silver, if present, is also unaffected. The second step embraces a wet treatment in which the impurities suspended in the alkali mix—sodium arsenate, sodium stannate, sodium antimonate and zinc oxide—are separated and recovered in the form of marketable products, substantially the whole of the alkali used being regenerated by simple means and returned to the cycle.

The process will be described under the two main headings of "dry treatment" and "wet treatment." The operation of removing arsenic, tin, and antimony will be referred to as "softening," and the elimination of zinc from desilverized lead as "refining."

Dry Treatment—Softening

Removal of Arsenic, Tin, and Antimony

Metal to be treated is caused to circulate rapidly in a finely divided state through a reagent contained in the cylinder of a portable self-contained machine resting on the rim of a kettle. Provision is made for feeding dry oxidizer into the cylinder at any desired speed when required.

The machine normally used is illustrated in Figs. 1 and 2. It comprises a steel framework *1* supporting a reaction cylinder *2* with its stirrer *3*, a plate feeder for dry oxidizer *4*, a pump *5* with vertical delivery *6* and distributor *7*, all of which are driven by motor *8*, the vertical shaft of which extends in both directions. All gearing works in ball bearings and is inclosed. The reaction cylinder, which can be removed independently of the machine, is in a heating envelope *9*, which the hot waste gases of the kettle furnace traverse by way of a truncated flue, *10*. The pump, of the centrifugal type, is designed to circulate lead at the rate of 10 to 12 long tons per minute.

In operation, the machine is placed on the rim of the kettle, with the reaction cylinder partly immersed in the metal. The cylinder is charged with molten reagent which, because of its lower specific gravity, floats on the surface of the metal in the immersed portion of the cylinder. Then the machine is set in motion and metal is thereby caused to circulate from the kettle through the distributor into the stirred molten reagent in divided form, passing back to the main body of metal in the kettle through valve *11*. The automatic oxidizer feeder

is set in motion by actuating clutch *12* and circulation of metal is continued until the desired degree of purification has been reached or the reagent in the cylinder has become spent by being saturated with the impurity. If the metal be purified before the reagent is spent, the machine or its cylinder may be removed into a fresh kettle of impure molten metal and the use of the reagent continued until exhausted. Any dross rising to the surface of the bath is charged to the cylinder during operation, so that none is collected.

When the reagent is saturated—when the point is reached at which, although the alkali is still fluid, any further action would tend to make it viscous—valve *11* on the outlet port is partly closed, when the incoming lead will displace the reagent, which will flow over a spout, as shown in Fig. 3, either directly into the wet treatment plant or into a ladle for transporting it thereto.

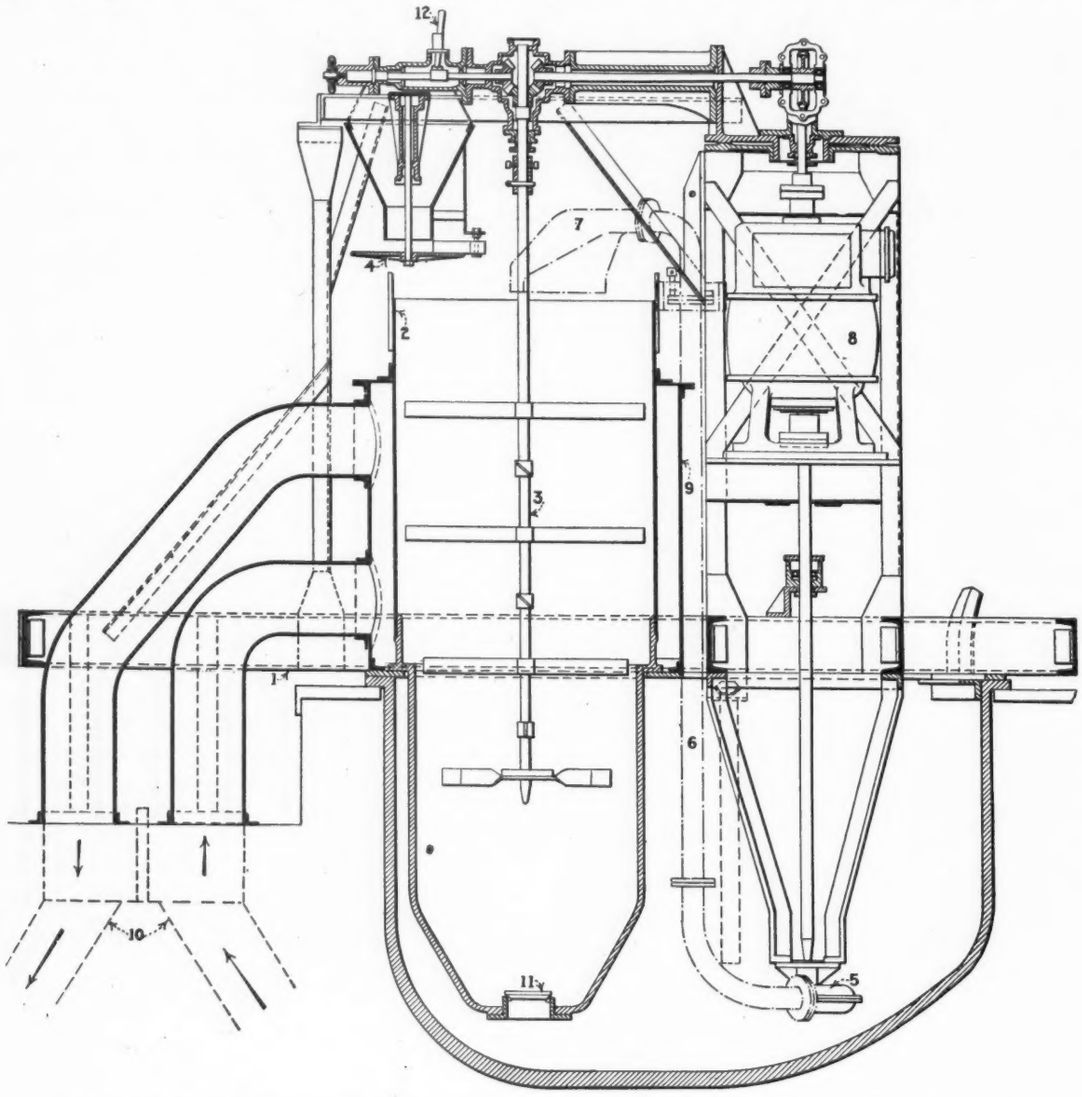


Fig. 1—Sectional plan of apparatus used for circulating molten lead through sodium salts in the Harris process

Elimination of the impurities takes place substantially in proportion to the rate of addition of the sodium nitrate, so the quantity of impurity removed at any stage of the operation can be determined fairly accurately from a knowledge of the quantity of oxidizer added. Generally speaking, arsenic, tin, and antimony leave the lead separately and in the order mentioned, but under certain conditions there is some overlapping, particularly between tin and antimony. With careful operation and regulation of temperature, however, the preferential removal becomes much more closely marked, so that the majority of the arsenic can be separated almost without tin or antimony, and most of the tin can then be eliminated without any appreciable amount of antimony. The separate removal of impurities from silver-lead bullion is not desirable; but in the treatment of alloys the preferential extraction becomes important, because arsenic and tin are first completely separated substantially free from antimony, leaving antimonial lead absolutely free from these impurities; and from this alloy pure antimony can be produced without difficulty in a separate treatment. This preferential separation is, however, only secondary, because all the metals are probably oxidized more or less simultaneously, forming alkali plumbate, antimonate, stannate, and arsenate. By virtue of their varying affinities for oxygen, these oxysalts mutually interact with the alloying constituents of the metal with which they subsequently come into contact. For instance, plumbate of sodium, by interaction

with arsenic, tin, or antimony, will be reconverted into metallic lead, oxidizing these impurities to form their appropriate alkali oxysalts. Sodium antimonate is converted into metallic antimony in contact with arsenic and tin, which it oxidizes, and sodium stannate oxidizes arsenic and is itself reduced to metal.

Thus a spent reagent containing sodium antimonate can be used for separating arsenic and tin from antimonial lead containing these impurities, in which case

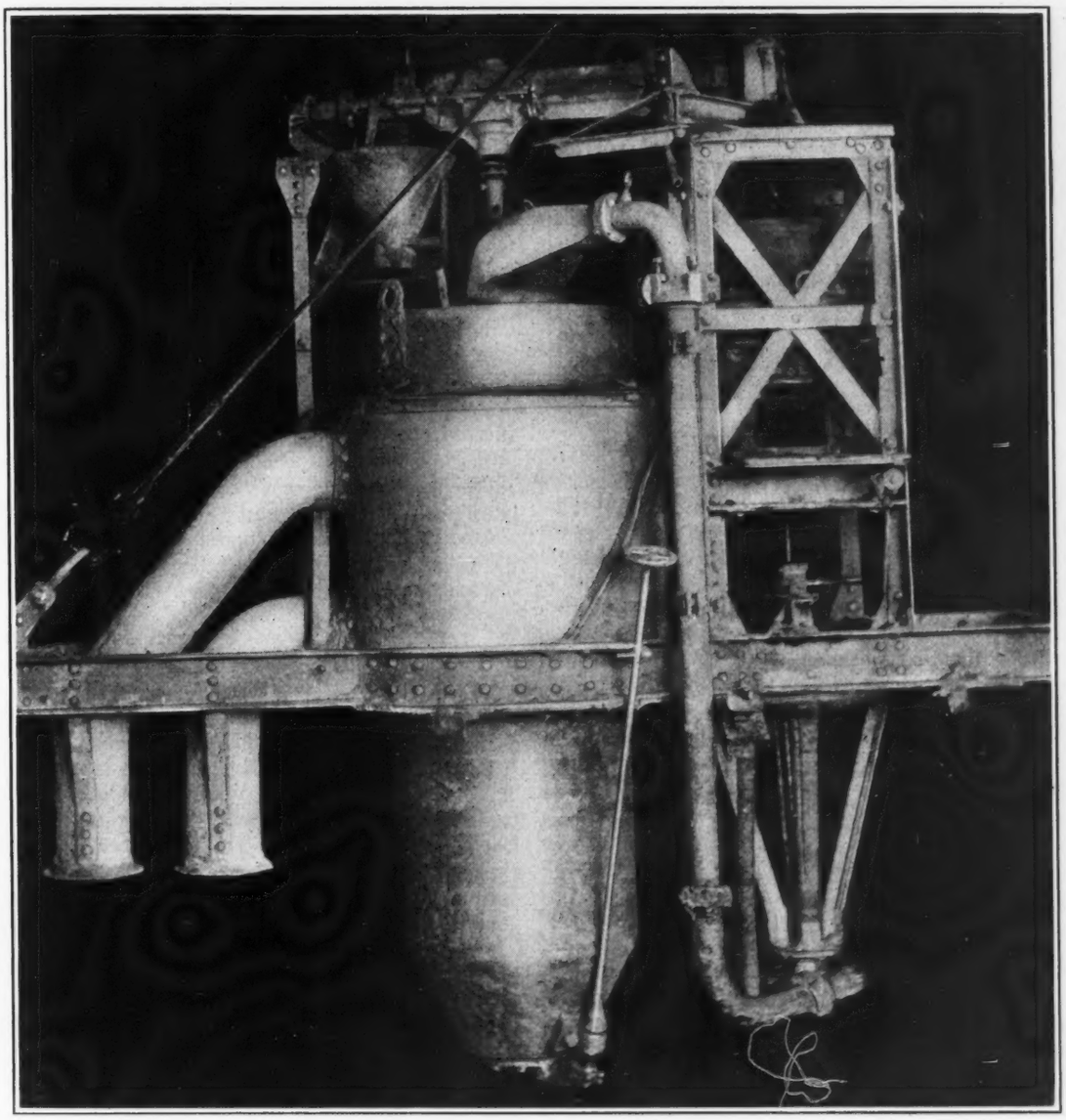


Fig. 2—The apparatus sets on the rim of a kettle, that portion below the horizontal framework being submerged in the molten lead

arsenic and tin replace antimony in the reagent, and the antimony in turn goes to concentrate that already present in the lead. Dry sodium antimonate can in fact be used for the extraction of arsenic and tin from antimonial lead, in which case it is used as a dry oxidizer and is fed from the machine in lieu of sodium nitrate. This feature is of importance, as will be noted later.

I. *Sodium Hydroxide*—The quantity of sodium hydroxide to be charged to the cylinder can be calculated from a knowledge of the nature and quantity of impurity to be removed. Used in conjunction with the appropriate proportion of sodium chloride and sodium nitrate, quantities computed in accordance with the following factors will produce a perfectly fluid melt:

Arsenic	x 2.90
Tin	x 1.92
Antimony	x 1.50

When these proportions are used, the spent reagent will contain the following percentages of any one impurity or a proportionate amount of a mixture thereof:

	Per Cent
Arsenic	18
Tin	26
Antimony	30

As to when the spent reagent is saturated and ready for removal from the cylinder, the quantity of oxidizer which has been added serves as a rough criterion; but it is also a matter of experience. It can best be judged by observing the nature and the number of metallic prills

in the slag adhering to an iron rod dipped into the molten reagent, which at near its saturation point begins to gather prills. A perfectly saturated reagent contains from 3 to 5 per cent of metallics.

II. *Sodium Chloride*—Sodium hydroxide alone is possibly capable of employment; but the commercial results obtained are very inferior and the use of sodium chloride is one special feature of the process. Its addition not only lowers the melting point of the mixture of alkali

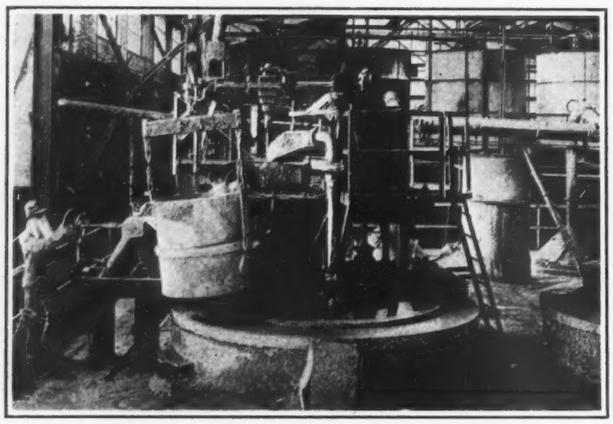


Fig. 3—A commercial installation of the Harris process

and oxysalts, but also enables larger quantities of impurity to be absorbed per unit of reagent. Its use also has certain advantages in other directions in the wet part of the process, as will be explained later. The quantity used is decided by the amount required to produce in the subsequent wet operations a caustic solution which will be saturated with salt when cold. It is roughly between one-quarter and one-third of the amount of hydroxide employed.

III. *Sodium Nitrate*—The following factors are used in calculating the quantity of commercial refined nitrate which has been found necessary in practice:

Arsenic . .	x 1.00
Tin	x 0.52
Antimony .	x 0.62

This is about 17 per cent less than the theoretical amount; but the balance of oxygen is supplied by the atmosphere through which the metal falls from the distributor of the machine into the reaction cylinder. The nitrate is completely dissociated into sodium oxide, nitrogen, and oxygen, and, unless water or steam be introduced into the melt (which was an original practice), sodium oxide will be found in the spent reagent to the extent of 36.6 per cent of the quantity of sodium nitrate employed, ultimately producing sodium hydroxide for subsequent use, to the extent of 47 per cent of the sodium nitrate. Hence in many cases more caustic soda is recovered than was originally fed to the cylinder.

It will be observed that the rate at which impurity can be removed will depend upon the rate of oxidation and the speed of circulation of impurities. The rate of circulation of impurities must keep pace with the rate of oxidation; hence, as the quantity of impurity in the lead grows less, either the rate of circulation of the lead must be increased to afford a constant speed of circulation of impurity, or else the rate of addition of the oxidizer must be reduced. It consequently follows that, with a given rate of circulation of metal, the rate of addition of oxidizer—and therefore the rate of elimination of impurity—will be higher with alloys containing much impurity than with, say, comparatively pure silver leads.

The single-pump machine most widely used is capable of circulating 10 to 12 long tons of metal per minute, and with this apparatus antimony can be eliminated from antimonial lead at the rate of one ton in two hours, and tin from alloys at the rate of one ton in five hours. On the other hand, in the treatment of silver leads, though high speed of elimination may be attained for a considerable proportion of the impurity, yet the necessity for working more slowly toward the end of the operation, when the quantities of impurity become quite small, considerably lowers the mean rate of elimination. This normally proceeds, for the average of a complete operation, at the rate of one ton of antimony in 10 hours, and one ton of arsenic and tin in 17 hours. Silver leads of more than average impurity obviously can be softened with greater speed.

Power, Fuel, and Labor

Pumping at the rate of 10 to 12 long tons of lead per minute, the total power consumed in the operation of the machine is about 16 kw.

The softening operation is exothermic, and consequently, during the operation of pumping, practically no fuel is required, excepting toward the end of the operation when the reaction is less pronounced. Substantially all the fuel used is that required to keep the metal hot before and after softening.

One man attends the operation of each machine and the firing of the kettle, together with the charging and discharging of reagent.

(To be continued.)

More Interest in Antimony in Canada

CONSOLIDATED MINING & SMELTING has made provision for the recovery of antimony as a byproduct from the silver refinery of its plant at Trail, B. C., according to Arthur Buisson, of the Canadian Department of Mines. This operation is still in the experimental stage, but a small production of refined antimony may be expected in the near future. Antimony is also recovered in small quantities from the silver-lead-bismuth bullion that is obtained by Ontario smelters in their treatment of silver-cobalt ores. The Lake George antimony mine, situated in York County, New Brunswick, is the most important deposit in that province, and is now controlled by the Canadian International Corporation, of Montreal. It is the intention of the Canadian International to incorporate an operating company to be known as the "Antimony Smelting & Refining Company." No crude ore will be shipped, and the company will devote its energies to the production of antimony regulus. The Lake George ore is stibnite, but native antimony is also found.

Although the production of antimony from Canadian mines was first recorded in 1886, shipments have been somewhat erratic and production has gradually fallen off, largely on account of the decline in the market price of this metal. Ores of antimony are known to occur, however, in British Columbia, New Brunswick, Nova Scotia, Ontario, Quebec, and the Yukon, and there are indications of a renewal of interest which may result in antimony being regularly included in the statistics of Canada's mineral production.

Comments on Present Practice at the

United Verde Concentrator and Smelter

Fourth Installment of a Series: Revisiting Arizona Mining Camps

By E. H. Robie
Associate Editor

BEFORE saying anything of the mill and smelter operations of the United Verde at Clarkdale, I must take the reader back for a moment to Las Vegas, Nev., whose local pride has been injured by a statement of mine in the March 31 issue in which I said: "From Tintic, Utah, to Barstow, Calif., and then to Kingman, Ariz., one traverses 800 miles of country without a mine of importance and apparently singularly free from mineralization." A reader in Las Vegas becomes very heated at this statement, intimating that I traveled in a car without windows (presumably with 39 other hommes) or in the "hazy atmosphere of the smoking compartment." As a matter of fact, I was asleep when traveling through this district, and the porter did not awaken me to point out the important mines; all I saw when I awoke was a grove of joshua trees.

Seriously speaking, of course, there is mineralization in this area—there is almost everywhere—but the mineralization is not sufficient to lead to the current operation of any large mines, which was the idea that I so imperfectly conveyed. In southwestern Utah, I know of no company that is now producing anything to speak of. In southern Nevada, along the railroad, there is, of course, the Pioche district, and the Goodsprings district, but what important mines are there? The only producing mines that amount to anything that I can think of can be named on the fingers of one hand—Bristol Silver, Combined Metals, Potosi, Yellow Pine, and Argentena Consolidated. In San Bernardino County, along the railway, north and east of Barstow, the only producer that I know of is the Vontrigger mine, north of Goffs. The most active of the properties mentioned produce only a hundred tons or so a day.

What my correspondent has in mind is chiefly the historical record. He speaks of the El Dorado district; the Bonanza King; of Calico, with a production record of $64,000,000 to $87,000,000; the Watterson; San Bernardino County, with a production of $200,000,000; and of the Potosi, Techatticup, 99, Yellow Pine, and Wall Street. I trust that due publicity has now been given to this area, and that it will, in time, regain its past glories and acquire new ones.

John E. Lanning, chief mechanical engineer of the United Verde Copper Company, described the new concentration plant in the *E. & M. J.* of Dec. 18, 1926, so I shall not repeat here the data there given. In operation, the mill has been highly satisfactory, though L. M. Barker, the mill superintendent, is not boastful of results, saying they have many problems awaiting a solution. In the article mentioned, Mr. Lanning told of the four-way type of scoop feeders for the ball mills, which were designed to eliminate scooping up of the initial feed. These have not been altogether satisfactory, and a return will be made to the standard type. The ball-mill drive — by synchronous motors direct-connected through magnetic clutches — has proved excellent. A marked surge in the classifier overflow was in evidence; these classifiers operate at 26 strokes per minute.

To me, the most interesting thing in the plant was a trial-unit installation of the flotation machine built according to plans provided by Harry D. Hunt, of the Miami Copper Company. This, as most of my readers know, is a simple machine, in this instance 35 ft. long, in which air at 1 to 1½ lb. pressure, freely admitted in close contact with the ore longitudinally along the bottom of the machine, lifts the pulp, which cascades over the side of the lifting compartment at the top. The cascade effect is said thoroughly to mix the air and ore particles, resulting in a fine dispersion of the bubbles. These then pass under a sloping baffle and are allowed to rise in a quiet chamber at the side from which the froth is removed. Provision is made for the release of surplus air used in lifting the pulp, but which does not remain in the cascaded pulp. The initial cost is low, the 35-ft. machine at Clarkdale costing only about $2,000, and it is said that for this particular installation a 50-ft. machine would have twice the capacity, or 600 tons, making a finished concentrate and tailing. The only power necessary is that used for compressing the air, and amounts to only about 1 kw.-hr. per ton, compared with 4½ kw.-hr for the mechanical type of cell used in the original layout of the plant. Repairs also promise to be much less.

Chalcopyrite and pyrite are the chief minerals in the ore. Microscopical work has shown that metasomatic reactions are continually occurring in the sulphides, that have a material effect on flotation results. O. E. Young, of the research staff, has recently made a special study of the use of the microscope in metallurgical analysis, under R. L. Head, of the Salt Lake Station of the U. S. Bureau of Mines, and some interesting results will no doubt be forthcoming. Tarnished chalcopyrite behaves much like pyrite in a flotation cell.

The following mill data representing recent average practice may be of interest:

Ore milled: Copper, 3.15 per cent; pyrite, 14; quartz, 24; schist, 49; sphalerite, 2; silver, 0.6 oz.; gold, 0.01 oz.

Recovery: Copper, 94.5 per cent; silver, 84; gold, 72. In the tailing is rejected 35 per cent of the pyrite in the ore, and 96 per cent of the schist.

Ratio of concentration: 4½ to 1.

Concentrate: Copper, 13 to 14 per cent; pyrite, 42 per cent.

Daily tonnage: 1,200.

Power consumption: 18.5 kw.-hr. per ton, including 2 for

coarse crushing, 9.5 for grinding, and 7 for flotation and other purposes.

Fineness of flotation feed: 5 to 7 per cent +65 mesh; 15 to 20 per cent +100; 65 to 70 per cent —200.

Expressing the analyses in terms of mineralogical composition is most effective in showing the operators just what is going on. The degree to which pyrite is dropped depends upon smelter requirements and costs.

Trona Used to Secure Alkalinity

Instead of lime, dry calcined trona is added at the ball mills to make the pulp alkaline for the purpose of precipitating the soluble salts in the ore—largely copper sulphate and ferric sulphate. It costs about $18 per ton, f.o.b. Searles Lake, Calif., and 2½ to 3 lb. of it per ton of ore is required. The trona gives very selective conditions in the flotation cells, resulting in a more scanty froth and but little flocculation. A small amount of sodium cyanide—from 0.05 to 0.5 lb. per ton of ordinary black cyanide—serves to depress the pyrite, but is also apparently actually beneficial in floating chalcopyrite. Phospho-cresylic acid (Aerofloat No. 15) is added to the classifier overflow to the extent of about 0.16 lb. per ton. It is, of course, a promoter, but has some selective action under the conditions existing in this circuit, for if xanthate were used in its place, no pyrite to speak of would be dropped. Dropping pyrite is not an important matter at this mill, for the ore contains only about 15 per cent of this mineral, as already mentioned. The cyanide is fed by the device developed by the American Cyanamid Company, and a simple pulley feeder is used for the other liquid reagents. Inclined channels of various sizes rest on the surface of a pulley as it revolves in a bath of the reagent, and the pulley speed may be adjusted as required.

The so-called superthickeners installed at the Clarkdale plant, six in all, are used without the filter bed at the bottom, as a sufficient amount of coarse material for this purpose is not available. Care must be exercised lest they be overloaded, with attendant breakage of gears.

About 30 per cent of the water used in the mill is recovered.

Representative analyses of a month's work follow:

	Cu	SiO_2	Al_2O_3	Fe	Equivalent FeO	S
Flotation feed	3.15	37.4	12.3	17.6	22.6	11.4
Flotation concentrate	14.1	3.2	2.3	33.4	42.9	38.8
Flotation tailing	0.19	47.8	15.1	13.2	16.9	3.7

The United Verde Smelter

In the United Verde smelter, the four blast furnaces are cold and deserted, though it is not just to omit mention of the excellent work done with them before reverberatories took their place. In these blast furnaces, which are 26 ft. 7 in. long by 4 ft. wide at the tuyeres, an average tonnage of 1,100 tons per day was obtained, using only 3.8 per cent coke on the charge. Of this charge, slightly over 11 per cent was lime, all the rest being copper-bearing material. This tonnage represents somewhat better than 10 tons per square foot of hearth area per day, but the low coke is, of course, the most startling feature, even granted that the ore is considered an easy one to smelt. Were the fuel much higher, blast furnaces would be out of the question here, as coke costs about $13.50 a ton. As it is without use for all of the waste heat, reverberatories would succumb to the blast furnaces; in fact, with the present equipment, should more furnace capacity be required than is furnished by the three reverbs that are operating, a blast furnace would be blown in.

The 24 roasters installed here are overloaded, all of the direct-smelting ore going through them after being crushed. This is detrimental to the dust loss, as it has been determined that the dust loss increases as the square of the tons per furnace day. The concentrates, which amount to about 250 tons per day, are not roasted, but are put through one of the roasting furnaces to mix them thoroughly with the proper flux.

Thorough mixing of the reverberatory charge is held decidedly important. Before it ever reaches the reverberatory charge hoppers, it should be as nearly homogeneous as it is possible to make it, so that the furnace reactions may take place with maximum speed. This is a point that has not had particular attention at many plants, logical as the reasoning may appear. The mineralogical constitution of the reverb charge must also be considered, it being more important that the assays; here, the ratio of schist to free quartz has a marked bearing on furnace tonnage.

Mineralogical Composition Stressed

F. H. Parsons, smelter foreman, described to me how the assays are interpreted in terms of mineralogical composition. The principal minerals present are chalcopyrite, sphalerite, pyrite, schist, quartz (available silica), hydrated iron, and calcium carbonate. It has been determined that four times the alumina percentage equals the amount of schist present, and there are other factors for determining the other mineralogical constituents. By so reporting the analyses, it is easy to conclude whether conditions are favorable to efficient operation. An effort is made, for instance, to keep the quartz about 19 per cent in the roaster feed, and the schist, 17 per cent.

Though there are six available reverberatories at Clarkdale, only three were in operation, two 25x100-ft. furnaces averaging 875 tons a day each, and a 19x100-ft. furnace averaging 675 tons. An excellent grade of Colorado coal, powdered in Raymond equipment, is used, the coal containing 13,300 B.t.u. About 265 tons is required for the above charge, or 9 tons charged per ton of coal—equivalent to a heat requirement of about 2,800,000 B.t.u. per ton. This can be improved about 10 per cent with ample hot material. For the 25-ft. furnaces 97 tons of coal per day is considered about right for economical firing. Conventional side charging is used. Skimming is not continuous, but is done as slowly as possible, occupying a little more than half the time.

Inquiring as to how these slags were sampled, I was told that an independent sampler walks from spout to spout, cutting across each slag stream with a sampling spoon several times during a skim, and granulating the samples in water. These samples are occasionally checked by channel samples on the slag dump. This is usually a more difficult job than it is at Clarkdale, for here the molten slag is poured on a separate dump from the skulls, resulting in a clean face of slag. Caves in the dump are also avoided, and the practice is considered well worth the time required for separate spotting of the pots.

The furnace arch is constructed entirely of silica brick, as are the walls with the exception of water-cooled iron plates, 4 ft. by 11 ft., with a copper tapping plate containing one cast-in perforated magnesite brick, and a water-cooled plate at the front of the furnace for

skimming. Two tap-holes are provided, about 30 ft. from the so-called front or flue end of the furnace; these tap-holes are about 6 ft. apart, and one is a little above the level of the other.

The longitudinal section of the arched roof of the furnace is straight at Clarkdale, though several of the Southwestern smelters retain the downward slope, toward the front of the furnace. Where there is ample cross-sectional area toward the flue end of a furnace with a sloping arch, apparently nothing would be gained by making it straight, except, perhaps, some simplicity of construction. Either method of construction seems approved practice, though care must be taken not to constrict the exit gas passages if maximum tonnage is desired. As constructed, and while cold, the center of the arch on the Clarkdale furnaces is 19 in. higher than the ends, at the skewbacks, in the 19-ft. reverberatories.

(To be continued next week)

The United Verde Mine, at Jerome

Above is shown a recent view of the open pit showing shovel and haulage equipment as described in the April 14 issue. Below, at the left, is shown an incline cut-and-fill stope; and at the right, waste filling in a horizontal cut-and-fill stope.

Selective Lead-Zinc Flotation Shows Big Increase

By W. R. Ingalls
American Bureau of Metal Statistics

THE increased use of the froth-flotation process and the introduction of the improvement therein that is known as selective or preferential flotation, which began about 1921 and became intense about 1925, has had a powerful effect upon the lead and zinc industries. Where previously the prospect had been for a continuing scarcity of both lead and zinc ores, there was a sudden change to a condition of plethora. The American Bureau of Metal Statistics has made a statistical estimate of the magnitude of these new supplies of ore so far as North America is concerned, and it is of course in the United States, Canada, and Mexico that this new process of ore beneficiation has found its most important application.

United States—The totals for the United States, exclusive of the Tri-State district, are summarized in the accompanying table.

Production of Flotation Concentrates, United States (Except Tri-State District)

(Quantities Shown in Tons of 2,000 Pounds)

Year	Lead: Total	Lead: Lead Content	Lead: Per Cent	Zinc: Total	Zinc: Zinc Content	Zinc: Per Cent	Zinc: Lead Content	Zinc: Per Cent
1921	107,237	44,904	41.87	38,433	15,311	39.84	4,457	11.60
1922	117,405	49,131	41.85	82,121	37,116	45.20	6,105	7.43
1923	166,777	70,166	42.07	169,496	83,778	49.42	11,181	6.60
1924	235,049	96,774	41.17	227,955	109,005	47.82	14,368	6.30
1925	320,513	139,264	43.45	253,989	130,594	51.42	11,064	4.36
1926	392,220	183,047	46.67	404,485	208,834	51.63	16,722	4.13
1927	451,617	220,236	48.77	499,706	265,146	53.06	12,293	2.46

For 1927 there were 37 producers reporting, outside of the Tri-State district. The number of mines producing ore subject to flotation separation was larger than that, several of the reporting mills being operated on a custom basis and receiving ore from numerous mines. The totals are short in that the productions of Park Utah, Silver King Coalition, and also three or four small producers were not received. It is safe to say that in the United States, outside of the Tri-State district, there are fully 50 producers of zinc ore whose product is beneficiated by the flotation process.

It may be assumed, nearly enough, that 95 per cent of the lead in the lead concentrate and 80 to 85 per cent of the zinc in the zinc concentrate are converted into metal. It may also be assumed that 95 per cent of the lead in the zinc concentrate is capable of realization so far as this ore goes to the process of electrolytic extraction; a lower percentage if the beneficiation be pyrometallurgical. Heretofore this new ore supply has gone to both those treatments, but it is to be expected that its destination will be increasingly toward electrolytic extraction.

In the Tri-State district the problem of mineral separation is relatively simple. Regardless of technical differences and considerations, however, the application of flotation in that district has had the same effect in increasing production as elsewhere, and substantially coincidentally. The distinction may be generalized in the representation that, whereas in other districts the flotation process has brought in ores that previously could not be treated, in the Tri-State district it has increased the percentage of recovery from ores previously treated. Out of the 274 miles in the Tri-State districts, 187 of which have mines with known ore reserves, perhaps as many as 100 now have flotation apparatus.

Returns of the American Bureau of Metal Statistics from the Tri-State district are so incomplete that no totals are offered for it further than the indication that its output of flotation concentrate was probably of 55 per cent grade in 1925, of 53.5 per cent grade in 1926, and of 56 per cent grade in 1927. The U. S. Bureau of Mines reports that in 1926 a production of 403,686 tons of gravity blende and 211,483 tons of flotation blende was made by 64 operators in this district. The production of the district in 1927 was in the aggregate less than in 1926, and probably was also less as to flotation concentrate. So far as conversion into metal is concerned, the Tri-State flotation concentrate has gone wholly to distillers, but it has developed profound changes in metallurgical conditions.

Canada—Statistics for this country are practically complete and are shown in the accompanying table. By far the largest producer of the Dominion is the Consolidated Mining & Smelting Company, owning and operating the Sullivan mine. In connection with that great producer the selective process got under way a little earlier, on a large scale, than in the United States. This appears in a great increase in the Canadian production in 1924. Otherwise the Canadian statistics reveal substantially the same developments as do those of the United States. Practically all of the Canadian zinc concentrate is now consigned for electrolytic extraction, but the output of some small producers in eastern Canada is exported for distilling in Europe.

Production of Flotation Concentrates, Canada

(Quantities Shown in Tons of 2,000 Pounds)

Year	Lead: Total	Lead: Lead Content	Lead: Per Cent	Zinc: Total	Zinc: Zinc Content	Zinc: Per Cent	Zinc: Lead Content	Zinc: Per Cent
1924	125,879	80,822	64.21	127,901	55,614	43.48	6,920	5.41
1925	161,103	101,908	63.26	168,252	75,454	44.85	6,296	3.74
1926	182,895	118,243	64.65	206,641	93,899	45.44	6,732	3.26
1927	204,754	137,789	67.29	206,867	99,909	48.30	6,074	2.94

Mexico—The returns from 17 operations in this country, beginning with 1925, give the following totals:

Production of Flotation Concentrates, Mexico

(Quantities in Tons of 2,000 Pounds)

Year	Lead: Total	Lead: Lead Content	Lead: Per Cent	Zinc: Total	Zinc: Zinc Content	Zinc: Per Cent	Zinc: Lead Content	Zinc: Per Cent
1925	108,622	34,308	31.58	85,308	41,693	48.87	2,305	2.70
1926	142,160	61,124	43.00	190,893	96,686	50.65	2,687	1.41
1927	211,107	96,316	45.62	268,160	138,250	51.56	5,327	1.99

By comparison with the Mexican official statistics, it appears that the totals given above are only a little short of the total zinc production of Mexico. Most of the zinc concentrate of Mexico is beneficiated pyrometallurgically, principally in Europe, but a small part of its ore is distilled domestically and a part is distilled in bond in the United States. Of the exportation of ore to Europe a small part goes to electrolytic extraction plants.

Mining and Treating *Lead-Zinc-Vanadium Ore in Northern Rhodesia*

By George L. Walker
London, England

THE Rhodesia Broken Hill Development Company, Ltd., has just completed at its property in Northern Rhodesia the first electrolytic zinc plant to be erected in South Africa. This plant, supplementing its lead smelter and flotation concentrator previously erected, was designed to give the company an annual productive capacity of 15,000 to 20,000 tons of slab zinc, 3,400 tons of lead, 315 to 630 tons of ferrovanadium (34 per cent V), and 35,000 oz. of silver. All these metals, totaling 19,000 to 24,000 tons yearly, are to be recovered from the treatment of only 55,000 tons of zinc and vanadium ores and blast-furnace slag!

Though the Rhodesia Broken Hill property has been worked as a lead mine for twenty years, its importance as a zinc mine has been realized for a much shorter time. It contains probably the richest known zinc ores occurring in large deposits anywhere in the world. The ores apparently are richer in combined zinc and lead than any others now being mined from large deposits, excepting only those of the Burma Corporation.

View of open-cut workings, No. 1 Kopje. Headframes of the two shafts are seen in middle background.

On Dec. 31, 1926, ore reserves were calculated as 935,000 tons of oxides averaging 30 per cent zinc, 8 per cent lead, and 0.9 per cent vanadium oxide (V_2O_5); 164,000 tons of sulphides averaging 34 per cent zinc and 20 per cent lead; and 38,000 tons of vanadium ores averaging 8 per cent zinc, 8 per cent lead, and 3.5 per cent V_2O_5. The total of the 1,137,000 tons of ore developed contains over 40 per cent of marketable constituents.

Until less than two years ago very little effort was made to ascertain the extent of the ore resources. The greater proportion of the tonnage given in the foregoing was developed while searching for and mining lead ores, more than 25 per cent of it already being in dumps on the surface. Since 1916 approximately 108,000 tons of lead has been produced, this yielding a slag dump estimated some time ago as 204,500 tons averaging 18 per cent zinc, 4.2 per cent lead, and 1.2 per cent vanadium oxide. As there was sufficient ore developed and slag on hand to supply the plant being erected for more than twenty years, there was no occasion to hurry exploration work; but a campaign of electric prospecting, diamond drilling, and underground development is now in progress.

The dam at Mulungushi impounds a lake 15 miles long and 5 miles wide

The country rock at Rhodesia Broken Hill is dolomite. Laterite containing in places enrichments of vanadium occurs as a recent flow deposit, and one well-defined belt of phyllites has been discovered. Little more than this seems to be known of the geology at present. The ore deposits are described as "the result of displacement of the dolomite along more or less vertical bedding planes and fissures." Massive sulphides are met at a depth of about 100 ft., though oxides, especially at the peripheries of the orebodies, in places go deeper.

Most of the ore deposits now receiving attention outcrop prominently above the surrounding level surface in the form of kopjes, or hillocks, rising from 30 to 90 ft. One of these has been mined down and is succeeded by an open pit 190 ft. deep, 700 ft. long, and 300 ft. wide, the lead ore having been smelted and the zinc ore piled in dumps along side. Other deposits which do not outcrop occur, apparently in some numbers, as ore has been encountered in unexpected places when excavating for various foundations. One such deposit, known as K-19, was discovered by extending the deeper workings of No. 1 Kopje. It is all sulphide, and at last reports the total tonnage of ore mined from it had averaged 26 per cent lead and 32 per cent zinc. At the 215-ft. level this ore deposit has a horizontal area of 4,000 sq.ft. The core from a diamond drill put down 135 ft. below this point averaged 20 per cent lead and 30 per cent zinc, and the hole was stopped in ore.

Known ore occurrences have been summarized by the management as follows: No. 1 Kopje, lead, zinc, and vanadium; No. 2 Kopje, zinc and vanadium; No. 2 Kopje, east extension, zinc; Nos. 3, 4, 5, and 6 Kopjes, lead, zinc, and vanadium; No. 7 Kopje, ironstone; "E" outcrop, northeast outcrop and Golf Course outcrop, lead, zinc, and vanadium; Old Office and Old Compound outcrops, ironstone; Camp and Foundry outcrops, zinc; Aërodrome outcrop, lead and zinc.

Though it probably would be possible to prove up a very large ore tonnage by drilling these several deposits, the policy of the company is apparently first to demonstrate the existence only of sufficient to warrant a substantial increase in the capacity of the electrolytic zinc plant. This done, development may be kept no farther ahead than economy of mining and an assured ore supply for the plants require, such a policy seeming to be dictated by the relative wetness of the mines. The normal dry-season pumping load is 5,000,000 gal. daily. During the unusual rainy season of 1925-26 this average rose to 11,000,000 gal. over a period of six months, in consequence of which a pumping capacity of 20,000,000 gal. daily has been provided.

Plant and equipment already are extensive and well

Hydro-electric power plant in the gorge below the Mulungushi dam, installed by Rhodesia Broken Hill Development Company

rounded out, ranging all the way from the mining and treatment of ore to the manufacture of lead sheets and pipes at the property; and power for all purposes is generated at the company's own hydro-electric plant. Conditions, natural and otherwise, have favored the construction work. The company owns exclusive mineral rights to 35 square miles surrounding the mines and approximately all of the surface of this area also. Situated 14¾ deg. south of the equator, the property is at an altitude of 3,880 ft. and is comparatively flat. It is on the main line of railway 2,015 miles north from Cape Town and 1,330 west from Beira. Such coal as is used comes from the Wankie Colliery, 442 miles distant. Native labor is plentiful.

Nearly all of the mining being opencast, only two of the shafts so far sunk are equipped for regular production. Both are at No. 1 Kopje and are down to the 225-ft. level. Cages are used for hoisting, the double-drum steam engines now being displaced by electric motors. Each shaft has four compartments, being 26 by 8 ft. outside the timbers. Two compartments of No. 1 shaft are used for hoisting; the others for ladderway and pumping. The pumps, two Boving horizontal, two Boving vertical, two Camerons, four Sulzers, and two Pulsometers, are so arranged that 11,900,000 gal. can be delivered directly to the surface from the lowest levels daily, and 8,200,000 gal. additional raised to the 150 ft. level sump, at which point a battery capable of delivering 10,800,000 gal. is installed. The water is discharged to a race 40 miles long, which delivers it into the Msweswe River.

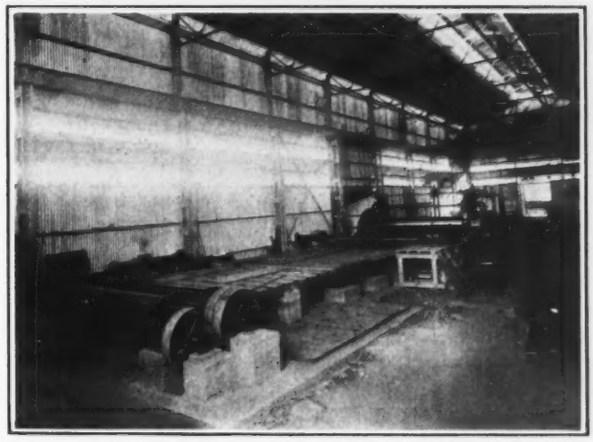
Mining at No. 1 Kopje soon will be all underground, as the opencast has there reached its economic limit. Underhand stoping methods will be employed. An Ingersoll-Rand compressor delivers 950 ft. of free air per minute to the jackhammers used in drilling. Mining costs, including pumping and stripping, are calculated at 8s. per long ton of ore.

The smelter consists of four water-jacketed blast furnaces, each of 150 tons' daily capacity. A gravity concentrator of 300-ton daily capacity was erected to increase the supply of lead charge for the smelter. It rendered good service, the ore being fairly coarsely crystalline, the zinc concentrates from it being stacked. From 86,757 tons of ore it recovered 35,794 tons of zinc and 16,537 tons of lead concentrates. This mill is in two identical units, equipment consisting of Blake Marsden crushers, Allis-Chalmers rolls, Harz jigs, Hardinge mill, and Wilfley tables. One unit will continue to operate, the other being converted to serve as the crushing and grinding division for the electrolytic zinc plant.

A flotation plant, consisting of a standard Minerals Separation machine of 14 boxes, 150 tons' daily capacity, was installed a year ago. It will be used to treat the slime from the gravity concentrator and for the further de-leading of the zinc concentrate. From the treatment of the first 15,152 tons of feed averaging 21 per cent lead and 34 per cent zinc, this plant recovered 2,624 tons of concentrate averaging 64 per cent lead and 11 per cent zinc. The tailings contained 12 per cent lead and 39 per cent zinc, the lead being mostly in oxidized minerals. These tailings are being stored, but will be re-treated to recover the zinc sulphides and will then be leached. Flotation zinc concentrates will be roasted for the production of sulphuric acid, afterward also being leached.

Six open hearths sinter the lead concentrates from jigs, tables, and flotation, granulated slag and fine oxidized lead ore being mixed with the charge. The product is crushed and sintered again for the elimination of the remaining sulphur, the secondary sinter going to the blast furnaces. Sinter, limestone, ironstone, and Wankie coke make up the smelting charge. From the lead well the metal discharges into a cast-iron pot heated by a small wood fire. A traveling bailing ladle dips the lead, after being drossed, from this pot and pours it into molds. All the slag is granulated and stacked, and the dross is re-treated in an old reverberatory. This lead is poled and averages over 99.7 per cent; that from the blast furnaces, over 99.5 per cent. A portion of the lead produced is sold to supply the South African market.

The Mulungushi River, below its confluence with the Msweswe, has been developed by the Rhodesia Broken Hill Development Company to supply sufficient hydro-electric power for the mining and treatment plants. A



The lead-rolling mill. Here lead sheets and pipe are made for consumption in South Africa.

dam across a relatively narrow gorge has impounded a reservoir lake some 15 by 5 miles in extent. The water is tapped from this by a tunnel and carried into the old river bed below, which it follows about 1½ miles to a service dam that diverts it to an artificial canal 2 miles long. At the end of this canal it drops 1,170 ft. through a steel pipe to the power station, which is built in a ravine. At first the plant was equipped to develop 3,150 hp., but additions are raising this to 15,000 hp.

As will be recognized by this description, the power-generating possibilities are much greater than this. They not only will provide for a large expansion of operations at Broken Hill, but also a surplus which may be sold. It is reported that Roan Antelope Copper Mines, Ltd., will obtain its power supply from the Mulungushi installation.

Sir Edmund Davis, chairman of the company, and the Anglo-American Corporation of South Africa, which acts as consulting engineers, seem fully to understand the nature of the undertaking they have in hand. The leaching installation was preceded by extended laboratory and pilot-plant experimentation and tests, and the process to be employed—an adaptation of the sulphuric acid leach and electrolytic process—was evolved by the research staff and is covered by patents taken out by the company.

It will be appreciated that Rhodesia Broken Hill is dealing chiefly with a metallurgical problem, as it has nothing but ore to treat, even its poorest tailings being, in this age of low-grade treatment, really rich ore. The problem is that of getting the greatest recovery possible at the lowest cost, of extracting vanadium as well as zinc and lead, and of protecting the market for ferrovanadium. It is this latter fact that is responsible for the flexibility provided in the capacity of the leaching plant. The type of ores treated will determine whether the output of ferrovanadium shall be 315 tons or 650 tons annually, and when the production of this alloy is only 315 tons, the output of zinc may be raised to 20,000 tons.

Pilot-plant tests indicated that 88 to 90 per cent of the zinc and 70 per cent of the vanadium in the ore will be recovered as commercial products. On smelting the residue of the leaching-electrolytic plant, it was found that the lead bullion contained 14 oz. of silver, or approximately three times the silver content of the lead recovered in the straight smelting of ores from the mine. As the zinc from Rhodesia Broken Hill ores contains no cadmium, it commands a high price.

The expenditure to bring Rhodesia Broken Hill to its present stage of development and equipment has been about $10,000,000, and the shares at this writing are quoted at a small premium over par. It is apparent that the company is still in a position to expand its production greatly.

Factor of Metal Price in Valuation of Mines

IN APPRAISING the value of their mines as shown on their annual balance sheet, the directors of the Federal Mining & Smelting Company made the following assumptions, which they believed to be correct to a high degree of probability:

"1. That our long experience leads to the conclusion that the per cent of metals in the ore reserves will continue in the future substantially as in the past, and, hence, that we may fairly accurately calculate the actual tonnage of metals to be ultimately obtained from present ore reserves.

"2. That operating costs for the next five years will be substantially as for the last five years. Changes, either up or down, are of course possible, but there is no present indication.

"3. That metallurgical recoveries will be no worse than in the past year. They should be, if anything, somewhat better, but are assumed as the same.

"Granting the reasonable accuracy of the foregoing assumptions, the future prices of metals become the all-important factor in the valuation. Here, we enter the realm of distinct uncertainty. But it is customary, in the mining business, for engineers and others who must estimate the value of a mine, to assume average prices of metals in the future equivalent to the average for a reasonable number of past years. Judgment as to the period to be taken must often be exercised. The years prior to the World War are of little value in estimating the future of lead and zinc, because conditions of production in the United States have so materially changed. The years of the war itself are also abnormal. After careful consideration, a ten years' period was decided upon. But this would include the last year of the war. To avoid this, a nine years' period, 1919-1927, both inclusive, has been used in making the valuation for 1927. This period includes years of both low and high average prices, and the average of the period is believed to be indicative of post-war conditions. At the end of the year 1928, it is planned to add the experience of that year, and thereafter to value the mines on the basis of average prices of lead and zinc realized for the preceding ten-year period. The silver content is not as important a factor as lead and zinc, and its price was more radically affected by the war and by the Pittman Act purchases immediately following the war. In its case, your directors have believed it wiser to use the average price of silver for a period of ten years, eliminating the period of the war and the four years following the war, and have taken the average price of silver for the four years 1924-1927, both inclusive, and the six years 1908-1913, both inclusive. With the passing of each year, the prices of the earliest year previously used will be dropped and those of the year just completed added.

"Your board of directors has used, and now plans continuing to use, the prices of metals actually received by your company. The average prices used in making the valuation for Dec. 31, 1927, are:

	Lead, per 100 Pounds	Zinc, per 100 Pounds	Silver, per Ounce
Prices used	$7.05	$6.54	$.586
These compared with prices on Dec. 31, 1927	6.50	5.65	.575

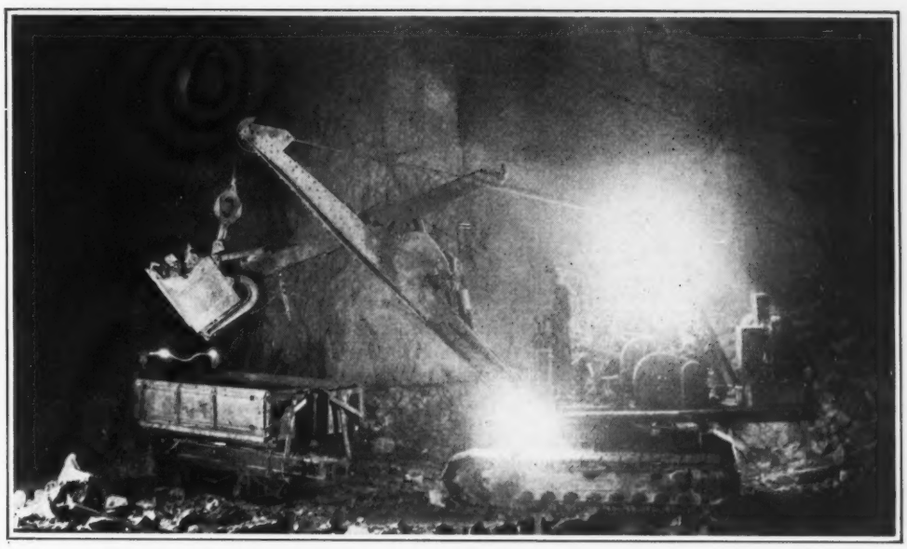
"While the method of valuation above described represents the best judgment of your directors and operating staff, it must be borne in mind that it is based upon assumed prices of metals for the future. If, in the future, lower prices prevail, this valuation will be too high; if higher prices, it will be too low.

"In making the calculations, the total expected profit has not been reduced to its present worth value, for the reason that it is believed that any discount will be more than offset by the discovery of additional ore reserves. Our valuation is based upon our estimate of known and probable ore only. What is now classified as 'possible ore' has not been taken into account, but will probably prove to be an important asset ultimately."

Mining Traprock Underground

Efficient Operations in Chestatee District in Georgia

By Claud Hafer
Mining Engineer, Southern Pines, N. C.



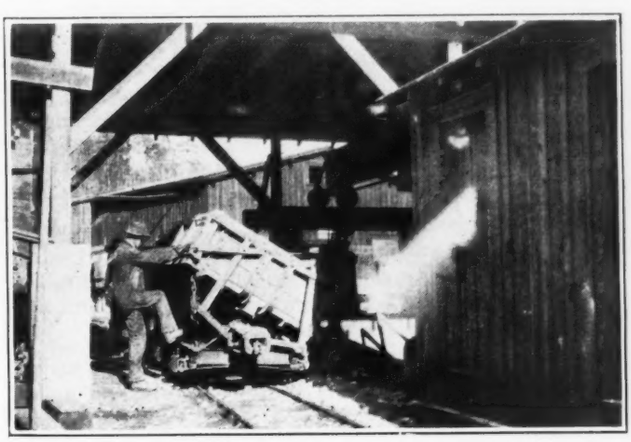
Electric-shovel loading underground. Marion machine on caterpillar base.

IN NORTH GEORGIA, in the Chestatee pyrite mining area, is one of the largest underground mining operations of its kind in the United States. The Piedmont Corporation, operating in the foothills of the Blue Ridge Mountains, has converted a pyrite mine into a producer of commercial crushed stone by widening out and bringing down to track level the old shrinkage stopes so as to permit the use of mechanical shoveling. Besides the primary advantage of having nearly developed working faces were others that facilitated the rapid opening up of a rock mine.

The country rock here is the Roan gneiss—actually a fine-grained schist. It is composed of hornblende, quartz, and mica, and is hard and resistant. The French coefficient is 22, which is high, ordinary rock being 10 to 15, with common trap somewhat higher. The trade name of this rock is Chestatee Trap Rock.

Two separate underground operations are being carried on. The first is reached through the original adit, driven along the trend of the pyritic orebody 1,200 ft. in length on the 100 level. Stoping was started 900 ft. from the portal, the pyrite-free rock on both sides of the

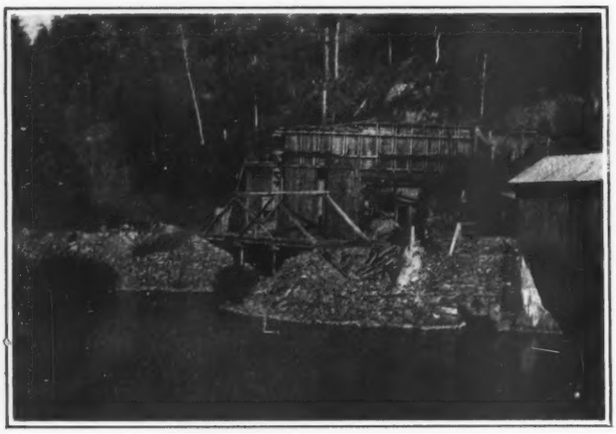
Dumping cars at primary crusher



Drifting with R 72 I.-R. drills

vein being broken, leaving mammoth chambers that stand without the use of timber. The stopes average 50 ft. in width, with a maximum of 70. The height is 80 ft., and the length depends on the surface contour.

A top sawtooth cut, 7 ft. high, is drilled by I.-R. R-72 machines column mounted and benched with DCR-23 Jackhamers back of the advancing cut. Benches are advanced 5 to 6 ft. every round and carried 10 ft. high. Gelatin, 30 to 40 per cent, is used; holes are "volley"



Hydro-power plant on the Chestatee River

fired by delay exploders, and blockholing is nearly negligible.

The broken rock is shoveled by a Marion 21 electric shovel, with standard boom, into 3-yd. dump cars, hauled by 4-ton, General Electric, battery locomotives. Two of these are in service. The trains pass through the tunnel 900 ft. to the crusher pit, 100 ft. from the portal.

The second opening is several hundred feet downstream from the first and nearer to the river. A tunnel 200 ft. long leads to stopes that are being advanced to the southeast. Eventually this will communicate with the original opening. The same system of breaking, loading, and tramming is in use here, with the exception that a Thew, type O electric shovel, is in service.

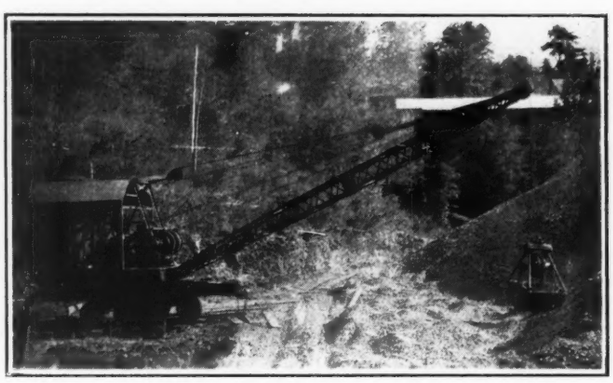
Trains from both places dump directly into a 42 by 48-in. Traylor jaw crusher, belted to a 150-hp. slip-ring motor. The crushed rock falls on a 36-in. conveying belt and is carried a distance of 435 ft. to the 750-ton storage bin, with a rise of 110 ft. Under this bin and fed directly from it are two Blake jaw crushers, discharging their product directly to a 30-in. inclined belt. Two similar inclined flights follow this, which feed the primary screens, of which there are two 42 in. by 8 ft. Stephens-Adamson revolving screens with dust jackets. The oversize is passed over a magnetic pulley to a 4-ft. Symons cone crusher, which is giving marked satisfaction, then returned by the same system of belts to the two screens. Undersize from screens goes over two Universal vibrating screens, where it is washed and sized into two commercial sizes and screenings.

Finished product is conveyed to cars on a track adjacent to plant or to stockpile by belt conveyors or launders. The stockpile can accommodate 10,000 tons, from which rock is loaded into railway cars by a one-yard clam-shell track crane.

Power is generated by damming the Chestatee and by an auxiliary steam plant. A wooden crib dam 300 ft. in length and 30 ft. high forms a reservoir two miles long. The storage capacity is limited, however, as water is taken from the crest of the dam. It flows through 600 ft. of ditch, to a wooden penstock directly over two 400-hp. Leffel turbines, discharging into concrete draft tubes. A total head of 40 ft. is obtained. One turbine is directly connected to a 335-kw. alternator. The other wheel is belted to an I.-R. Imperial, type 10 compressor and to a Worthington triplex pump, which supplies water for washing rock and for fire protection. The auxiliary steam plant consists of two 250-hp. marine-type water-tube boilers, hand fired with coal. These furnish steam for a 500-kw. G. E. turbo generator. This plant is for emergencies and to supplement periods of low water in the river, generally the dry months of late summer and autumn. A warehouse, a fairly equipped machine shop and drill shop, employing a Sullivan class A sharpener and an I.-R. 25 oil furnace, complete the mine plant. Part of the equipment here has been adapted from that used in mining and milling pyrite ore; but lately the new crusher and conveyor were installed, and the plant was almost entirely rebuilt, which has doubled capacity, now estimated around 750 tons per 10-hour day.

The corporation owns its own railroad, 10 miles of standard-gage track, to Clermont, on the Gainesville & Northwestern Railroad, which provides outlet for general distribution at Gainesville, via the Southern Railway and the Gainesville Midland. The great bulk of the product is consumed in road and highway construction and in building construction in general.

The mine tract contains about 900 acres, presumably underlain with rock of commercial quality and providing a reserve for many years, assuming that economic conditions permit of working only from the present floors. Overburden in this region varies from a few feet to 60 ft. thick, so the underground mining does away with stripping. An added benefit is the avoidance of idleness



Locomotive crane reclaiming from stock piles

of men and equipment in rough weather, as well as better service generally during the entire winter.

On the plateau back from the river, on less rugged terrain, is the village, company owned; also the general store and boarding house. The safety organization consists of heads of various departments of mine and mill. Meetings are held every Monday, and serious accidents and injuries are rare.

The property is owned by Piedmont Corporation, of which A. Fillmore Hyde, New York City, is president, A. G. Loomis, secretary-treasurer, and G. A. Austin, resident manager. Nelson Severinghause, a mining engineer from Arizona, is superintendent of operations. The last two gentlemen have kindly facilitated and given valuable data for the writing of this article.

COMMENT AND CRITICISM

A Metallic Mercury Myth Exposed

THE EDITOR:

Sir—I write you at the instance of Mr. Charles Butters, with whom I was recently examining a mercury property in Guadalcazar, State of San Luis Potosí, Mexico. In conversation he informed me that he, in company with Mr. Gould, the mercury expert of San Francisco, expected to visit the deposits at Altamira, on the gulf railroad 16 miles north of Tampico, where mercury occurs in metallic form.

I related to him that I had examined this property in October, 1926, and my account of it so impressed him that he thought in view of the general interest taken in mercury deposits at present that a description of the one at Altamira might be of value to the readers of *E. & M. J.* who are interested in this metal from a commercial or scientific standpoint.

Altamira is an old town built on the shore of the Laguna de Champayan, or estuary of the Tamesi River. The subsoil consists of a clay bed about 3 meters thick, resting on a layer of broken oyster shells mixed with clay about 2 meters thick; underneath this there is more clay. The whole is evidently a beach deposit, the broken and worn shells having been washed up by the waves into their present position.

At fourteen places through the town drops of mercury can be washed out of the ground; the intervening spaces seem to be barren. The largest drops are found near the surface, getting smaller as they go down, until the oyster bed is reached, where little pools have collected in the upturned shells.

The deposit is the more remarkable because it does not seem to be an isolated one, but rather to belong to a chain of deposits of the same class in this district. I was assured that eight or ten leagues up the lake, and again at similar distances north or northwest, other deposits of metallic mercury have been found. Observe that I am careful to use the term "metallic" and not "native" mercury, for reasons that will appear later.

The layman would be thunderstruck by such accumulations of "easy mercury," waiting to be washed out, and think that he had a "gold" mine. If so plentiful, he will doubtless ask, why do not the natives wash it out of their back gardens? Alas! the bubble must explode and his dreams of riches vanish when he knows and understands the history of mercury in Mexico! I have heard of this Altamira at intervals during the last 30 years, but interested parties always "found it out" before we could make the trip down.

When Mexico, or Nueva España as it was then styled, still belonged to Spain, the mining of mercury ores was prohibited in Mexico, so as not to interfere with the market for the produce of the government mines of Almaden. Enormous quantities of the metal must have been shipped into the country to meet the demands of the rich silver mines that treated their ores by the patio process.

I may mention that no sign is evident of cinnabar or other mercury minerals (except a trace of secondary chloride), nor of any thermic action, in these clay deposits. Altamira was the old port—the ruins of the quay still exist—where the ships from Spain put in. Tampico had not been thought of at that time; in fact that port was founded by the inhabitants of Altamira comparatively recently.

In former times the now so well-known iron flasks had not been invented, and the mercury was shipped in a more fragile container. Most of your readers, acquainted with mule or burro transportation, will know how the animals mill and bang each other about. One can look back through the vistas of the past and see the Spanish galleons anchored at the wharf, and strings of Indian slaves unloading the packages of the precious mercury. . . . A foot slips on the gangway and 75 Spanish pounds of mercury drop down to "salt" the muddy bottom. The remainder of the containers are safely distributed to the different "mesones" or inns, ready for loading the pack trains in the early morn.

If not set down carefully many may have been broken, and one knows how mercury will penetrate the minutest crevice. Those who have dug up old patio floors know also that it will penetrate down to a depth of 50 to 60 ft. in the ground. Barely daylight, and the pack animals are loaded. One bumps against another and lo! a fresh lot of mercury is spilled into the manure of the corral to improve further the "salting" of this valuable Altamira deposit! The eight to ten leagues to the next "depot" is a day's journey for the pack train, and the mercury is again exposed to the dangers of unloading and repacking. Another "corral deposit," to coin a new mining term! The other resting places are all on the old pack trail up to the still famous and, in ancient times, rich mining camps of Catorce, Charcas, Zacatecas, Fresnillo, Parral, and others too numerous to mention.

The packers must have been careful, otherwise more mercury would have been lost in transit. This reminds me of a story Mr. Butters told me of the "discovery" of a new petroleum field, which was traced to a leakage in his fuel-oil supply pipe line concealed from sight in the tropical jungle.

I am wondering whether this Altamira case is unique or whether other engineers have had similar experiences elsewhere. Anyhow, this is a peculiar case, and I hope will be of interest to your readers and possibly raise a laugh in some lonely camp in far-off wilds.

W. ERNEST FRANKS.

San Luis Potosí, Mexico.

* * *

The Mining Engineer and the St. Francis Dam Disaster

THE EDITOR:

Sir—On my return from an extended Southern trip, I noticed the interesting editorial in *Engineering and Mining Journal* of April 14 dealing with the failure of the St. Francis dam in California. The comments therein are indeed pertinent.

I have been wondering why the mining profession has not been called upon more extensively in connection with the studies of this failure. The Committee on Ground Movement and Subsidence of the A.I.M.E. is engaged in the study of problems involved in earth and rock movements, and from time to time has sponsored the publication of papers dealing with this general subject. For example, there is now a paper before the Publications Committee on the Gros Ventre Landslide, by W. C. Alden, which was read before the subsidence session of the Institute last February. George S. Rice has also made some important contributions to this subject in his studies of the Turtle Mountain landslide.

It seems to me that the Committee on Ground Movement and Subsidence might well give its attention to the problems involved in connection with the foundations of dams, and that the authorities concerned with these problems might well make use of the facilities of the committee in this respect. The committee has an outstanding member, Dean Probert of the University of California, who is particularly well qualified to initiate such studies on the Pacific Coast. The committee comprises many experts whose views might well be sought. It also seems to me that the special knowledge possessed by members of the Ground Movement and Subsidence Com-

mittee is going to waste if it is not called upon in connection with the further development of this broad problem of safety of dam foundations.

New York. H. G. MOULTON.

* * *

"E. & M. J." Articles as Texts in German High Schools

THE EDITOR:

Sir—We have received a letter from Dr. K. Glinz, professor in the Technical High School in Berlin, in which he requests that we send him several reprints of Mr. Miller's articles on high-speed rolls. These articles appeared in the issues of Feb. 11 and 25, 1928. This gentleman desires to use these in his school work. We would like to secure about six copies for Doctor Glinz.

TRAYLOR ENGINEERING & MANUFACTURING COMPANY,

New York. By G. R. H.

[We are always glad to comply with such a request, which should be made early—before spare copies are unavailable.—EDITOR.]

* * *

Rubber as a Launder Lining

THE EDITOR:

Sir—In regard to the exhaustive review on "Rubber in the Mining Industry" in the issue of Jan. 14, it might interest readers to know that the ordinary plantation crepe mat laid down in the extension tailings launder of the Kamunting Tin Dredging Company's No. 2 dredge in June, 1923, and originally described in *E. & M. J.*, is still in position and shows practically no sign of wear. Apparently, as long as no undue crushing or tearing strains are put on this material, and it is not subjected to much direct sun exposure, its length of life is so far unknown. In fact, it may be said that running sand appears to have no appreciable wearing effect, although, of course, this material cuts through even manganese steel very quickly. This particular launder is exposed to the sun, but it is seldom that a thick layer of water and sand are not running over it.

The Wilkinson Process Rubber Company, a local organization, is producing a reinforced semi-vulcanized product, which promises to stand up to most conditions of launder lining, and this so far is promising well in the most difficult position—*i.e.*, in the screen oversize chute where ordinary crepe is entirely unsuited.

On jig dredges, particularly, where there are many launders distributing sand, rubber has great use.

ROY L. NAISH.

Kamunting, Perak,
F. M. S.

* * *

The Structure of a Diatom

THE EDITOR:

Sir—Your interesting cover of Dec. 24 reminded me of a remarkably fine photomicrograph of a single diatom from the Lower Miocene of Maryland—the so-called Maryland Beauty *(Heliopelta Marylandia)*. This was a particular pet of the late Rev. Edward Huber, who was among our foremost microscopists.

The photoprint, which is 3½ in. diameter, was made by Dr. Lewis E. Jewell, Research Laboratory, Eastman Kodak Company, by a special method of his own, and shows more minute detail than any previously made that I have chanced to examine. Dr. Jewell was formerly expert observer with the late Prof. H. W. Rowland, of Johns Hopkins, in his solar spectrum work.

Baltimore, Md. A. B. BIBBINS.

* * *

A Matter of Courtesy

THE EDITOR:

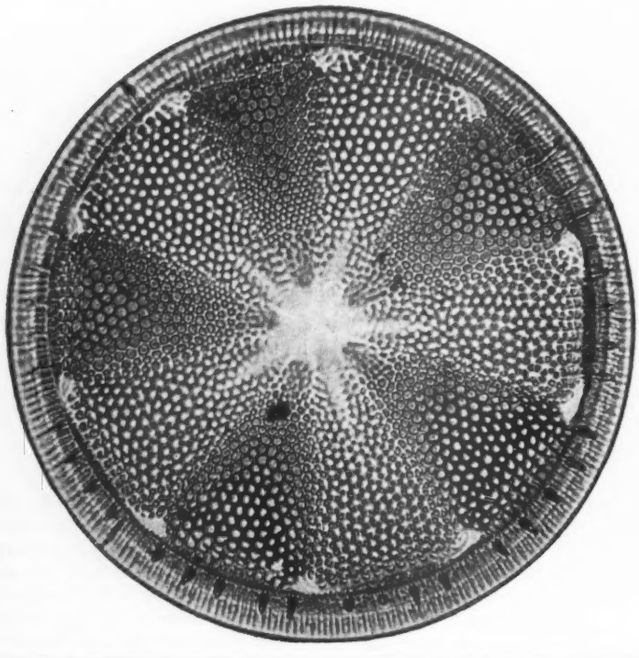
Sir—A recent paragraph in the Searchlight Section of *E. & M. J.* regarding the courtesy of acknowledging applications for positions makes me think of the English way. In the engineering journals published in England it is customary to print a final advertisement reading about as follows: "The Consolidated Mining Company desires to thank those who have sent applications for the position to be filled and to advise them that an applicant has been chosen."

This is a simple way to reach all the applicants, equally applicable, if it is not desired to reveal identity. We use this plan and find that it is appreciated.

MARK R. LAMB.

Buenos Aires, Argentina

Photomicrograph of *Heliopelta Marylandia*, X 305



By the Way

Prehistoric Oysters

ON THE BANKS of the lower Potomac River at Wailes Bluff, near Cornfield Harbor, Md., may be seen a thick bed of oyster shells, now high and dry above tide level and covered by several feet of earth. How did they get there? Is it a kitchen midden of the long ago, left by the Indians or their predecessors? Geologists say no; the bed is vastly older than that, and the oysters lived and died where they now are and owe their present high position to changes in water level and not to human agency.

This ancient oyster bed and adjacent deposits that include a more varied assortment of shells are pictured by W. C. Mansfield in a short report entitled "Notes on Pleistocene Faunas from Maryland and Virginia and Pliocene and Pleistocene Faunas from North Carolina," just published as Professional Paper 150-F of the U. S. Geological Survey. Although the oysters that inhabited these shells lived during the final stages of the "Ice Age," the temperature of the sea must have been about the same then as today, or perhaps a little warmer, for Mr. Mansfield finds that a kind of clam that now flourishes in Mobile Bay then lived near the mouth of the Potomac River.

In the course of his field studies Mr. Mansfield observed cypress stumps 6 to 8 ft. in diameter buried beneath 22 ft. of sea shells, sand, and clay, on the Neuse River below New Bern, N. C. He infers that the salt water of the ocean invaded a cypress swamp at this point, killed and truncated the trees, and deposited sand, sea shells, and mud upon them. This was in the latter part of what geologists call the Pleistocene epoch, which began perhaps 1,000,000 years or more ago. The

stumps may be as much as 100,000 years old. Later the sea withdrew, and the marine deposits were gradually cut through by the river until the old stumps, thus far well preserved by exclusion of air, again became visible.

* * *

Breaking the Monotony at a Mining Center

A PROGRAM of a recent entertainment arranged by the English Club at Rio Tinto, Spain, indicates that work abroad may be lightened effectively by co-operative effort in an endeavor to inject a little humor into what might otherwise develop into humdrum routine. The feature of the evening in question was a play, "Produced by E. G. Lawford, formerly at the *E.&M.J.* Studios, New York." After an interval of fifteen minutes, "during which the bar will be open," a sketch was staged, the characters in which, "in order of their disappearance," included the part of the "Shop Girl," played by "Sta. Inflamación de Jámon y Huevos." The program contained a note that "The perpetrators of tonight's disturbance disclaim all responsibility in case of suit for defamation of character, libel, or breach of promise." The advertisements on the program satirize various company activities. For instance, the Infant Welfare Center purports to ask "Does your baby have pains in its stomach after a big feed of pork chops? If so, bring it to the Center and have its horrorscope taken out." Even at this distance one can picture the "disturbance" sponsored with the aid of an ex-member of our editorial staff. More power to such diversions.

* * *

Still Another Method of Prospecting

MUCH of the world's lacteal output originates with the genus *Bos.* Nor is the production of milk the sole field in which the cow has distinguished herself. Mining till recently had no reason for holding the placid mammal in special regard. Today, however, it would seem that the bovine molar is destined to take its place beside the Eötvös torsion balance as an aid to the prospector. Basis for this prediction may be found in advices from the *Oregon Journal,* which state that eight Idaho cattle, destined for inglorious slaughter, were granted temporary respite when it was found that their crushing equipment had accumulated appreciable amounts of auriferous ore. The presence of gold in a tooth is not a rare phenomenon of our civilization, but it has customarily been limited to the human species. It was evident that the particular bovines under examination had never been subjected to dental supervision. The presence of the precious metal could therefore only be accounted for if it was native to the heaths over which the octette had roamed. A gold rush to Star, Idaho, the original habitat of the creatures, is expected, for this is a grassroots proposition.

Consultation

Pointers on Precautions Against Mine Fires

"Have you any published rules on safe practices calculated to minimize the hazard of fire in underground mines?"

Perhaps the following suggestions, made in a recent paper by Dan Harrington, of the U. S. Bureau of Mines Safety Department, give as much good advice on this point as can be compressed in a small space:

1. Every mine or working place in which more than five men work should have more than one opening for ingress and egress of both men and air. In mines reached by shafts more than 300 ft. deep there should be hoisting equipment in more than one shaft.

2. Every mine (coal or metal) employing five or more men should have mechanically controlled ventilation, preferably through a fan located on the surface in fireproof housing and so arranged as to allow of prompt reversal of direction of air currents in case of necessity. The approach to the fan from the shaft should be fireproofed also.

3. No timbered shaft should act as both intake and return.

4. Every opening leading from every shaft should have in it and reasonably close to the shaft a fireproof or fire-resistant door such that by closing these doors air flow to or from the shaft may be excluded at any or all levels in case of necessity. Unless this system of doors is maintained at all times along all timbered shafts leading into deep mines (even if not used at ordinary times) there is danger of suffocation to all or practically all men in the mine in case of fire in the mine and especially in case of fire in or near the downcast shaft.

5. Ventilation doors should be solid, tight, and fire-resistant; they should be equipped with a latch to keep them closed in case of reversing of direction of air and, where made automatic, the automatic feature should be positive as to closing the door rather than holding it open.

6. The shaft or shafts in which men are hoisted should be intake (or downcast).

7. Downcast shafts should preferably be lined with concrete or other absolutely fireproof material.

8. Underground electrical stations should be fireproof and all electrical equipment and wiring carefully safeguarded as to fire.

9. No open lights, smoking, torches, or other flame ought to be allowed in any mine where timber or other inflammable material is used or found.

* * *

Viscosity

"Please explain the meaning of '100 seconds Saybolt viscosity' with respect to lubricants?"

Viscosity means that property possessed by all oils in varying degree by virtue of which their flow is retarded. It may be regarded as the internal friction or the resistance offered by the particles of an oil in sliding past one another. It is a measure of the lubricating value of an oil. Viscosity is customarily measured in commercial practice by the Saybolt universal viscosimeter, which has been adopted for this purpose by the American Society for Testing Materials. This does not show the true viscosity, because the tube is too wide and too short for the real friction of the oil to be accurately registered. But it serves to classify oils in the order of their viscosities, according to Lockhart.

The procedure is to take the time required for a certain quantity of the oil being tested to flow through an orifice of standard size under standard temperature conditions. Specifically with respect to lubricants, viscosity constitutes the measurement of the number of seconds required for 60 cu.cm. of oil to flow through the standard orifice at the standard temperature. According to the Texas Company, this is usually 100 deg. F. for the lighter products, such as engine and machine oil. For heavier oils, such as gear compounds and steam cylinder oil, 210 deg. F. is commonly used. Therefore, when an oil is referred to as having a Saybolt viscosity of 100 seconds at 100 deg. F., it implies that 100 seconds will be required for 60 cu.cm. to flow through the standard Saybolt viscosimeter at 100 deg. F. Viscosity varies inversely with temperature; that is, the higher the latter the more fluid will the average lubricant become. In true liquids it is inversely proportional to the fluidity.

* * *

Arsenic Determination and Power-Factor Control

"If you would find it convenient to answer the following in your consultation column I would be greatly obliged to you:

"How is arsenic determined quantitatively by distillation and titration with iodine and how is the iodine standardized with arsenious acid? Can this method be used for antimony?

"What is meant by the term 'power factor' and how is it calculated?"

According to Mahin's "Quantitative Analysis" (McGraw-Hill Book Company), the official method for the determination of total arsenic in paris green is based on the volatility of arsenic trichloride with steam. The sample is dissolved in concentrated hydrochloric acid in a distilling flask. Cuprous chloride is added to reduce any pentavalent arsenic. The distillate containing the arsenious chloride and hydrochloric acid is absorbed in cold water. Excess of acid is then neutralized with sodium hydroxide, sodium bicarbonate is added in excess, and the arsenic is titrated with standard iodine solution. The reactions will be found on pp. 244-45 of the textbook mentioned.

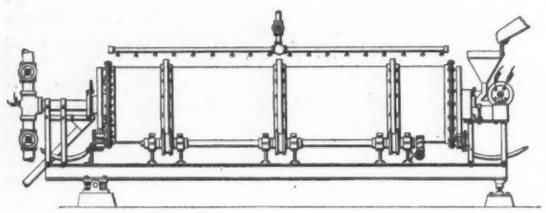
See also Griffin's "Technical Methods of Analysis," pp. 149-51 (McGraw-Hill Book Company). An article in the February issue of *Coal Age* discusses power-factor control.

INDUSTRIAL PROGRESS

The Equipment Review

SOME new ideas in the design of furnaces, power shovels, and transportation equipment feature the week's news of mining and metallurgical machinery. A brief digest is given in the following:

An electrically heated furnace, designed primarily for heating and reducing ores, but also intended for distilling oil shales and similar applications where accurate control of temperature is desired, has been patented by F. E. Hatch, Denver. It is covered by U. S. Patent No. 1,665,546. According to the inventor, it represents an improvement over furnaces previously patented by him. It consists essentially of a drum horizontally disposed and so supported that the angle with the horizontal may be changed. It is lined with refractory brick, through passages in which the electric heating elements or wires pass. These elements are arranged in parallel and connect with collector rings at the ends of the drum. Air pipes run the length of the drum, being set on the inner surface of the lining in recesses in the brick. Ore is injected into the drum at one end by a hot-air blast from a blower, which air is heated by being passed through the pipes referred to. The finished product is discharged at the opposite end. The furnace is shown in the accompanying sketch.



An electrically heated furnace for distilling oil shales and reducing ores

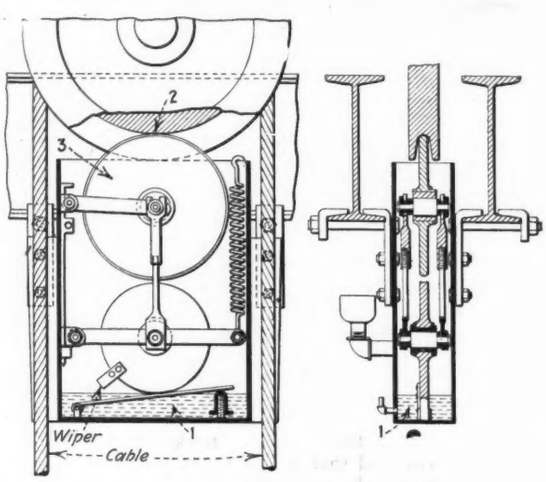
A furnace for producing metallic tin from tin concentrate has been devised by William J. Cayzer, Kaapmuiden, Eastern Transvaal, South Africa. It has a revolving hearth with a cast-iron bedplate sloping slightly to the center, where vents are situated for the discharge of the recovered tin. The process followed uses the addition of carbonaceous material in proper proportion to the ore or concentrate, both in a finely divided state. A porous bed is formed on this hearth. Water- or air-cooled rabbles or arms above the bed discharge the iron contained in the mix, also the surplus carbonaceous material, into a vent immediately above the hearth at the side of the bed. The inventor claims that the process of reduction, which takes place at 900 to 950 deg. C. with the proper fuel and gas conditions, effects a separation of iron and tin, producing "Standard" tin. The furnace is described in greater detail in the *South African Mining and Engineering Journal* of March 3. It is claimed that the reducing reaction is as follows: $SnO_2 + 2C = Sn + 2CO$. To effect this reaction, according to Mr. Cayzer, certain conditions in the furnace must be maintained—namely, temperature control and presence of a reducing gas.

Roasting furnaces equipped with a low-pressure oil burner known as the Mahrvel Calorizer are familiar. This burner has been manufactured by the Mahr Manufacturing Company, Minneapolis. The company is now introducing a "triple-atomizing" oil burner. This operates on low-pressure air between 8 and 10 oz. per square inch. Part of the air is induced so that the burner will operate on less air from the blower. The fuel is atomized over three separate and distinct knife edges, located on the oil sleeve, in the chest and the nozzle. With this design, it is claimed, it is possible to burn the fuel completely without excess air or fuel. The burner can be adjusted to different fuels so as to secure the proper amount of air for each. A short flame can be produced if desired.

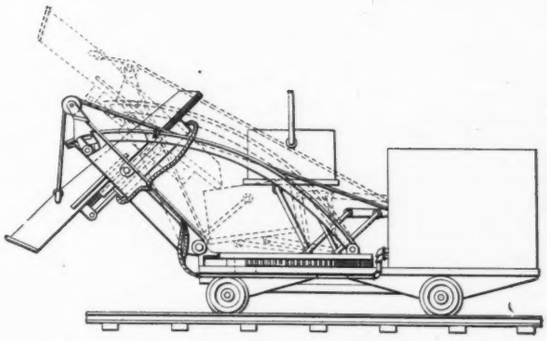
Haulage, Hoisting

The Swedish General Electric Company, of Vesteras, Sweden, has recently furnished several electric locomotives to the Grangesberg Gemensamma Gruvforvaltning, Grangesberg, Sweden. The locomotives work continuously on three shifts. The normal train consists of a motor and 30 cars, the total weight being 147 tons. The motors are totally inclosed and are ventilated by a closed-circuit air-cooling system. Each locomotive has two railway-type 31 hp. motors (500-volt, 320 r.p.m.).

A device for lubricating wire ropes and cables running over drums or sheaves has been patented by L. G. Gates, Bakersfield, Calif., and assigned to the Standard Oil Company of California. It is covered by U. S. Patent No. 1,665,451, applied for in 1926. Its purpose is to provide simple means for lubricating a rope acceptably; for feeding the lubricant in relatively small quantities but regularly to the rope; and for insuring that the lubricant will be applied to the inner side of the rope. The accompanying sketch shows the essential features. The lubricant is applied at the bottom of the sheave groove so that it is transferred to the inner side of the rope by contact. Furthermore, the centrifugal force acting on the lubricant tends to work it out into the

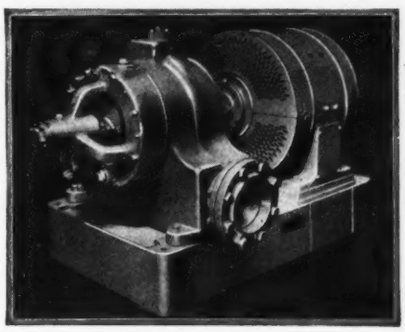


Device for lubricating wire ropes and cables as they pass over their respective drums or sheaves



The principal feature claimed for this design of power shovel is that it will permit work in unusually small space and also upon the back

strands of the rope and to advance it up the sides of the groove so that it will be applied to the entire inner surface of the rope. The sketch shows the side elevation of a crown block of an oil derrick with its sheaves and cable. The lubricating apparatus includes a holder for a supply of oil lubricant at (1) between the runs of the cable below the sheave. A mechanism for transferring the lubricant periodically to the bottom of the sheave groove at (2) is provided. This mechanism may be of any suitable construction. It takes small quantities of lubricant from the bath at one extreme of its movement and transfers them to the bottom of the groove at the other.



This centrifugal pump is self-priming

The rotation of the wheel (3) provides the movement which effects the reciprocation or oscillation necessary for feeding the lubricant on to the sheave.

Power Shovels

Ernest E Peterson, Carson Lake, Minn., has designed a power shovel (U. S. Patent No. 1,665,378; filed 1924), which is intended to be operated in an unusually small space so as to permit rapid excavation and deposition of the excavated material in a suitable conveyor. The design provides a chute, integral or connected with the bucket proper, so arranged that by merely tilting the chute and bucket the load may be hoisted and deposited in a conveyance receptacle. A further object of the shovel is to provide a means of operating upon the roof as well as upon the front or end or sides of a restricted underground passage. The general design is indicated in the accompanying sketch.

A new gasoline shovel, known as the "Conqueror," has been introduced by the Osgood Company, Marion, Ohio. It is of the full-revolving type and is fully convertible to dragline, back hoe, clamshell, and crane service. It is tractor-mounted. As a shovel, it carries a 20-ft. boom, a 15-ft. handle, and a back-hitch type dipper. For crane service it carries a 45-ft. boom of the lattice bow type. It is operated by an 80-hp. 6-cylinder gasoline engine.

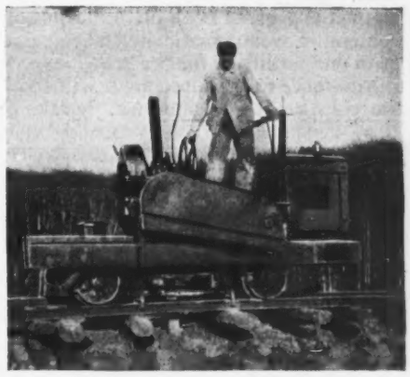
Pumps

A single-stage, double-suction, inclosed-impeller, vertical split-casing volute-type centrifugal pump, known as the Jennings, is being marketed by the Nash Engineering Company, South Norwalk, Conn. It has a self-priming device consisting of a built-in Nash vacuum pump mounted on a shaft which is connected by a flexible coupling to the main pump shaft. When starting, the self-priming device, or air rotor, quickly exhausts the air from the suction piping and casing, so that full rated capacity is delivered without delay. No ejectors, hand pumps, power vacuum pumps, or foot valves are required. This device is supplied in standard sizes up to 1,000 gal. per minute.

Transportation

The Westinghouse company has developed for main haulage purposes an electric locomotive which involves the most up-to-date engineering design. This is a 38-ton, 36-in. gage, 3-axle, 6-wheel locomotive having a total horsepower of 399 and semi-magnetic series-parallel control. Forced ventilation is used to increase the motor capacity. Various improvements have been introduced. The locomotive is intended to haul 46 to 60 3½-ton (gross weight loaded) cars over grades varying from 2.37 to 5.6 per cent, a distance of 21,150 ft. at an average speed of 8½ miles per hour. It will be on exhibit at the Cincinnati Exposition, May 7-11.

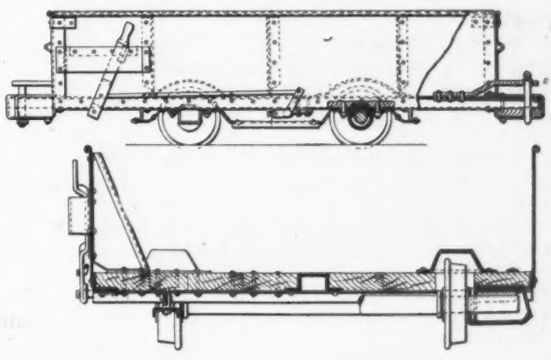
A mine car of the general design shown in the accompanying sketch has been patented (U. S. Patent No. 1,665,390) by Victor Willoughby and assigned to the American Car & Foundry Company, New York. Here the object has been to provide a mine car of composite structure, large capacity, and low maximum height, and at the same time make it of strong construction and inexpensive. The plate-girder side-sills fastened together form a rigid frame for this car and are reinforced by gusset plates secured to the floor. The car is of the center-bumper type, having a drawbar and buffer beam suitably reinforced at the coupler members and bumpers. Improved braking means have been provided.



A track-shifting machine for use on narrow-gage roads

Haulage

A track-shifting machine for moving track as narrow in gage as 36 in. has been introduced by the Nordberg Manufacturing Company, Milwaukee. This is known as the Model O. For the last three years the company has been building a machine for standard-gage track and is now introducing the new model to meet the demand for a machine for narrow gages. The principle of operation is the same in both models. Owing to the smaller dimensions of the new machine, it has been possible in designing it to simplify the controls and decrease the weight. The power unit consists of a 4-cylinder 15-hp. gasoline engine. The machine can be propelled at two speeds—namely, 4½ miles per hour and 13 miles. The lifting device can



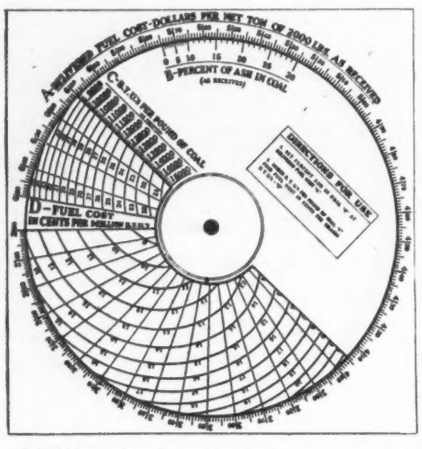
Features of this design of mine car, it is claimed, are strength, large capacity and low height

lift 42,000 lb. at a maximum of 15 ft. per minute. The frame is of 8-in. channels with welded joints. Its width is 5 ft. 5 in., and the length 12 ft. 1 in. The wheelbase is 5 ft. 5 in.

Steam Plant

A new form of slide rule known as the "fuel value computer" has been developed by the Coal Specialties Company, 50 Church St., New York. This device is arranged to make easy the calculation of the cost of fuel per million available B.t.u. when delivered cost, ash content, and calorific power are known. Based on the best of present-day combustion engineering practice, the scales are so calculated that the fixed charges which must be made against any given coal, owing to its ash content, are automatically taken care of in one setting of the scale.

Reference to the illustration will show the construction of the rule. Scale *A*



A "slide rule" for calculating the cost of fuel when certain factors are known

is plotted around a series of curves printed on a sheet of flexible material on which is mounted a semicircular rider carrying scales for ash and B.t.u content. In use, the delivered cost per net ton of coal is set on Scale *A* against the ash content of Scale *B*. Opposite the calorific power on Scale *C* may be read the cost per million available B.t.u. By means of the computer the actual cost of different fuels may be quickly obtained.

On the back of the computer are tables for conversion of cost on a gross-ton basis to that on a 2,000-lb. basis. The computer thus contains in itself all that is necessary to make any coal comparison. Its data are said to have been so utilized that the results apply equally well for any type of boiler firing.

Concentration

A centrifugal machine for extracting gold, especially fine gold, from gravel without the aid of quicksilver is being introduced by the Logan Mining & Machine Company, 911 New York Avenue, N.W., Washington, D. C. The circular of this company, which is the source of the foregoing information, does not go into details.

Miscellaneous

Among the miscellaneous supplies recently announced is a workman's cap known as the "Antaxicap," which has two hooks on the front for holding the workman's goggles when these are not in use. The goggles are furnished with the cap. These eye protectors may be attached to any style of miner's, shop, or railroader's caps. The manufacturer is the Wilkes-Barre Cap Manufacturing Company, 88 East Northampton St., Wilkes-Barre, Pa.

Another device for safety purposes is the safety shoe made by the Lehigh Safety Shoe Company, Allentown, Pa. These shoes, it is said, are being used in various copper and other ore mines as well as in bituminous mines. The shoe has a safety box toe so constructed that it will withstand considerable pressure either from standing weight or from falling objects. No metal is used in building the toe, so that the wearer's toes cannot be pinned fast should the toe of the shoe be crushed. The box toe used is of such construction that if crushed at all it is entirely crushed, in which case the foot can be removed immediately. The shoe is also intended for shop use.

PATENTS

TUYERE EXTRACTOR. No. 1,665,135. April 3, 1928. G. J. Jones and E. J. Suren, assignors to Gramewell Blanning, New Castle, Pa.

WELDING. No. 1,666,026. April 10, 1928. Robert Applegate, assignor to the Ohio Brass Company, Mansfield, Ohio.

A process of welding copper bonds to railway rails which comprises disposing the bond adjacent a rail, heating the rail and melting a portion of the bond by means of an electric arc, placing a quantity of calcium silicon in contact with the molten bond metal, and melting additional copper to complete the weld.

WELDING. No. 1,665,461. April 10, 1928. Henry S. Holmes, assignor to Thomas E. Murray, Brooklyn, N. Y.

In welding a pipe to the inside of a cylinder a method which consists in providing a projection on the inside of the pipe and pressing the latter against the cylinder by pressure applied to the projection.

MAGNESIA REFRACTORY. Nos. 1,664,630-631. April 3, 1928. William Koehler, Cleveland, Ohio.

Two processes, one for producing magnesium oxide and calcium carbonate from raw dolomite and the other for producing refractory magnesia compounds from dolomite.

ZINC OXIDE. No. 1,664,767. April 3, 1928. F. G. Breyer, E. H. Bunce and J. H. Weikel, assignors to New Jersey Zinc Company.

A method of improving zinc oxide for rubber compounding use, which comprises reducing the acidity of the oxide by the action of steam.

ACID PUMP. Nos. 1,665,458-459-460. April 10, 1928. Aladar Hollander, assignor to Byron Jackson Pump Manufacturing Company, Berkeley, Calif.

These three patents cover respectively an acid pump, a means for packing the pump, and a means for priming it.

PIPE CUTTER. No. 1,665,212. April 10, 1928. C. H. La Motte, South Porcupine. Ont.

ROCK DRILLS. No. 1,664,786. April 3, 1928. Spiro Mumovich, Anyox, B. C.

A dust collecting device for rock drills.

ROCK DRILL. No. 1,665,497. April 10, 1928. C. C. Hansen, assignor to Ingersoll-Rand Company.

Certain improvements in an air-line oiler as an accessory to a rock drill.

WELDING. No. 1,665,815. April 10, 1928. Alfons Mauser, Cologne-Marienburg, Germany.

A longitudinal seam-welding machine.

BLAST FURNACE. No. 1,664,832. April 3, 1928. W. P. Power and E. Lewis, assignors to the Broken Hill Proprietary Company, Australia.

SINGLE ROLL CRUSHER. No. 1,664,877. April 3, 1928. M. E. First, assignor to C. O. Bartlett & Snow Company, Cleveland, Ohio.

MOUNTING FOR ROCK DRILLS. No. 1,665,269. April 10, 1928. Earl B. Lear, assignor to Ingersoll-Rand Company.

BULLETINS

BITUMEN GUN — Quigley Furnace Specialty Company, 26 Courtland St., New York. Bulletin 301. Quigley bitumen gun. Four pages.

SOOT BLOWER—National Flue Cleaner Company, Inc., Groverville, N. J. Folder covering National soot blower for horizontal return tubular boilers.

PULVERIZER — George F. Pettinos, 1206 Locust St., Philadelphia. Four-page bulletin. The Centripact pulverizer for hard materials.

COTTRELL PRECIPITATION — General Electric Company, Schenectady, N. Y. Bulletin GEA-916. Electric apparatus for use with Cottrell precipitation process. Sixteen pages.

INDUSTRIAL NOTES

R. D. Nuttall Company's commercial activities will be handled in the future by and through the parent company—namely, the Westinghouse Electric & Manufacturing Company. J. E. Mullen, formerly assistant sales manager of the Nuttall company, will be in charge, with offices at the Nuttall plant at Pittsburgh.

H. D. Savage has been elected president of Combustion Engineering Corporation, New York, succeeding Joseph V. Santry. Mr. Savage was vice-president for many years. George T. Ladd has been elected vice-chairman of the board.

NEWS OF THE WEEK

Summary

"IT IS to the interest of the state to render possible the recovery of at least a considerable percentage of the gold remaining in the Sierras," the commission appointed by the Commonwealth Club to investigate hydraulic mining in California has reported. Page 748.

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Postmasburg manganese deposits in South Africa may be developed by the Union government in its program of fostering a South African steel industry. Page 751.

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Verdict by jury favors Argonaut Mining in the suit started by Kennedy Mining for $1,500,000 for damage in the fire of 1919. Page 746.

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Additions to surface structures at the North Lily will facilitate an increase in production at that silver-lead property in the Tintic district of Utah. Page 747.

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Tamarack & Custer will abandon its mill on Canyon Creek, in the Coeur d'Alene district, and divert ore shipments to the Hercules mill, at Wallace. Page 749.

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British tin interests are seeking to stimulate use of the metal, and thereby increase price, by propaganda. Page 751.

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Construction of the surface plant at the Frood mine of Mond Nickel is to be started soon. Page 746.

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New York section of the A.I.M.E. hears Professor Taggart discuss flotation on April 25. Page 750.

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Microscopic work at the laboratory of the Intermountain station of the Bureau of Mines is an invaluable aid to the metallurgists in the Salt Lake Valley district. Page 747.

Tariff Commission to Investigate Tungsten Production Costs

Increased Bauxite Imports Result From Higher Mining Expense in Arkansas—Potash Development by Government Urged

By Paul Wooton
Special Washington Correspondent

AN INVESTIGATION into the costs of tungsten production in the United States and in China is to be undertaken by the U. S. Tariff Commission in accordance with the Oddie resolution, which has been approved by the Senate. The Senate took this action after Senator Oddie had explained that the producers of tungsten in this country had faced unfavorable conditions since the enactment of the present tariff law in 1922. At that time, he explained, there were very large stocks in the country as a result of the surplus built up during the war. Tungsten could be sold at a price which could not be met by domestic producers. Production was suspended until 1925, when stocks became low enough to warrant the reopening of the low-cost mines. The delivery cost on tungsten imported from China was reduced, however, with the result that the domestic operators could make no profit. Some production was continued in the expectation that the internal disorders in China might cut off that source of supply. Senator Oddie pointed out that despite the facts noted heavy imports have continued and that domestic production must cease unless a higher rate of duty can be applied. With that in view he introduced the resolution which has just been approved.

The investigation will be under the immediate direction of F. Morton Leonard, the mining engineer who heads the Tariff Commission's section handling minerals. Although the number of producers of tungsten in the United States is small, the task involved presents difficulties because of the complicated accounting work which will have to be done. It seems certain that no foreign field work will be necessary, as exact information is available as to prices being paid for the imported product.

Steadily increasing imports of bauxite are accounted for by observers in Washington as being due partly, at least, to Arkansas' severance tax and to the increased cost of mining there. Conditions surrounding production are so much more favorable in British Guiana and in Dalmatia that it is feared that more and more of our requirements will come from those sources. In addition, probabilities favor large production, in the not distant future, from India, Nyassaland, and the Gold Coast. For these reasons it is felt that every effort must be made to free domestic producers from any unnecessary burdens, such as a severance tax.

Testimony in favor of the development of potash deposits in the United States was presented at the meeting of the House Mining Committee on April 27 by J. H. Hedges, assistant to the director of the U. S. Bureau of Mines, and by Dr. George R. Mansfield, of the U. S. Geological Survey. Both appeared in connection with the bill introduced by Representative Winter, of Wyoming, which seeks to authorize an appropriation for the extension of exploration work to be carried on jointly by the Bureau of Mines and the Geological Survey.

In the course of his remarks, Mr. Hedges called attention to the fact that the cost of potash in this country increased from $33.75 per ton to $288.45 per ton in the war period, because of the cutting off of the foreign supply. Dr. Mansfield gave a brief description of the areas where potash occurs. He said that the Salt Lake desert brines contain 2 per cent of potash. "These brines," he continued, "are similar to the German brines, and would possibly yield magnesium chloride." He also asserted that the commercial production of potash in this country is entirely feasible.

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Management Recommends Enlarging Montana-Idaho Mill

The management of Montana-Idaho Mines recommended the enlarging of the company's mill at Spring Hill to a daily capacity of 400 tons at the recent annual meeting. The mill now handles 175 tons a day. Arrangements to remedy the power difficulties at Winston, Mont., have been made. It is expected that operations will be started soon on the East Pacific Mine, at Winston.

New Mines Building at University of Utah Nears Completion

Structure Will Provide Necessary Additional Laboratory Space for Research Department and Intermountain Station of the U. S. Bureau of Mines

RAPID progress is being made in the erection of the new mines building at the University of Utah, the cornerstone of which was laid with appropriate and interesting ceremonies on Oct. 7 of last year.

Erection of the building was made possible by the Legislature of the State of Utah, which at its last session not only increased the appropriation for the research work that the university is carrying on in co-operation with the U. S. Bureau of Mines, but also appropriated $45,000 for the construction of this building to provide additional necessary laboratory space required by the department of mining and metallurgical research of the university and for the work of the Intermountain Station of the Bureau.

The action of the Utah state legislature is attributed particularly to the foresight and efforts of the university authorities, the mining committee of the Salt Lake Chamber of Commerce, the Utah section of the American Institute of Mining and Metallurgical Engineers, and influential members of the mining industry of the various mining districts tributary to Salt Lake.

The building, which is situated just east of the metallurgical building, where it will form an integral part of the mines group of buildings on the north side of the campus, will comprise three stories. On the first or ground floor, in addition to furnace, storage, and supply rooms, a machine shop and smoke and mine rescue laboratories will be installed. Microscopic and ventilation laboratories, two lecture rooms, and three offices will be located on the second floor. About one-third of the top floor will be used for a technical library, the remaining space providing quarters for gas fuel and hydrometallurgical laboratories, a drawing room, and two offices.

The building will be completed and ready for occupancy about July 1, it is expected.

Jury Decides in Favor of Argonaut in Kennedy Case

Suit for $1,500,000 Damages as a Result of Fire in Argonaut Mine in 1919 Ends in Defendant's Victory

AFTER deliberation of one and three-quarter hours, the jury in the suit of Kennedy Mining & Milling vs. Argonaut Mining for $1,500,000 damages rendered a verdict in favor of the latter. The trial, which was held in Jackson, Calif., from April 16 to 30 before Judge C. P. Vicini, resulted from damage done by the fire in the Argonaut mine in March, 1919.

Warren Olney, of San Francisco, attorney for the Kennedy company, opened the case by describing the methods used by the Argonaut company to extinguish the fire. He said that both mine shafts were sealed when the fire was discovered and the mine filled with carbon dioxide gas. It was left in this condition for a week, reopened, and the fire area isolated by bulkheads. It is claimed that the fire was permitted to burn for more than ten months, with the result that it spread to the Kennedy mine, which immediately adjoins it. No opening statement was made by Argonaut.

W. E. Downs, of Sutter Creek, Calif., testified to the positions of both mines and described conditions from a model. E. Higgins gave testimony about the methods used in extinguishing the fire. Ben Sanguinetti testified to the revival of the fire and the necessity for bulkheading. Webb Smith, superintendent of the Kennedy; Alex Rose, Joseph Phelps, and William Sinclair, all described mine conditions. James Spiers, former superintendent of the Kennedy, gave estimates of the loss resulting to the Kennedy company because of the conditions created.

W. S. Kelsey, who was superintendent of the Argonaut at the time of the fire, testified in detail to the measures taken by the Argonaut company to check the spread of the fire into the workings of the Kennedy mine. Kelsey also testified that, prior to the flooding of the Argonaut mine, the Argonaut company offered to put the fire under control in the Kennedy mine at the expense of the Argonaut, the offer being refused. He also stated that the Argonaut mine was flooded to prevent the bottom of the mine filling up with débris that would have resulted if the Kennedy started flooding first. A number of other witnesses were also called to testify for the defense.

The fire in the Argonaut mine in 1919 caused the shutdown of both mines until May, 1921, when they were unwatered and subsequently reopened in the fall of 1921. In 1922 a second disastrous fire occurred at Argonaut, in which 47 men lost their lives.

U. S. Zinc to Add to Smelter at Amarillo, Tex.

An addition to the United States Zinc Company's smelter at Amarillo, Tex., is to be constructed, increasing the capacity of the plant about 15 per cent. At present the smelter employs about 300 men.

Frood Plant Construction to Start Soon

Shaft Sinking to 3,000 Level Completed —Diamond Drilling Shows Large Orebody at Sudbury Basin

WORK is now under way in preparation for the erection of surface plant and buildings on the Frood property, in the Sudbury mining area of northern Ontario, following completion of shaft sinking to a depth below 3,000 ft., which was accomplished a few weeks ago. The building and equipment to be installed will form a necessary adjunct to the huge underground campaign and heavy development of the Frood mine, scheduled to be brought to fruition in 1931 by the International Nickel Company. Concrete foundations for most of the surface buildings have been poured. All the equipment for the largest mine shaft in Canada is now on order, including two hoists with drums 12 ft. in diameter by 7½-ft. faces. The ore hoists will be separate from the hoist for lowering and raising men and supplies. The ore hoist will take a 10-ton load, and will be driven by a direct-current motor of 3,200 horsepower. Measurements of the shaft are 28 ft., 2 in. by 16 ft., outside the timbers.

The possibilities of the Sudbury Basin Mines have been considerably improved as a result of diamond drilling both east and west of the original discovery. The original discovery was also proven by diamond drilling, which indicated a body of ore similar to that on the Errington mine of the Treadwell Yukon Company, over a length of approximately 500 ft. Recently a hole was drilled about 1,500 ft. to the west, and a good intersection was obtained. Another hole was then drilled approximately 1,000 ft. to the east. This has just been completed and has cut ore of commercial grade. This indicates that ore persists over a length of at least 3,000 ft., and the probabilities are that further drilling will show more ore.

The accuracy of electrical surveys on this ground has been demonstrated, and according to the electric surveys there are other indications two or three miles away which are equal to if not better than the area proved by diamond drilling.

Only One Mining Man Captured by Nicaraguan Rebels

Dispatches to New York newspapers have disclosed that in the raid of rebels, supposedly allied with the Sandino forces, on two American-owned mines in the Pis Pis district, only one American was captured. Early reports said that George Marshall was killed, but the more recent dispatches say that he is safe, though in the hands of the raiders. One report even says that he is working the La Luz mine for them. Mr. Marshall was assistant manager of the La Luz. All the other foreigners at the mines escaped safely, including two Americans and one Englishman.

Microscopic Work Valuable To Operators

Investigations of the U. S. Bureau of Mines Result in Increased Mill Extraction

By H. D. Keiser
Assistant Editor, Salt Lake City

RESEARCH work carried on at the microscopic laboratory of the Intermountain Station of the U. S. Bureau of Mines is rapidly becoming an increasingly important factor in the metallurgical practice of the district. In several instances results obtained have enabled operating companies to reduce their mill losses appreciably, with a resultant greater recovery of valuable minerals in the ores treated. It is also apparent that, although the use of the microscope in solving metallurgical problems is just being developed, its application will soon be considered essential in the further development of both ore-dressing and smelter methods.

In the course of the microscopic investigations at the station, which are in charge of R. E. Head, microscopist of the U. S. Bureau of Mines, it was found that knowledge regarding the minerals in many ores now being treated is lacking; that is, numerous companies are treating ores in order to make mineral separations and are not fully advised regarding the minerals that occur in their ores. It is therefore evident that they do not know the exact nature of the minerals that are being lost in their tailings, inasmuch as such losses are reported in percentages of metal obtained by chemical analysis. Recent investigations have established this fact with regard to a certain class of oxidized lead ore. The ores in question contain a considerable portion of their lead content in the form of plumbojarosite, a mineral that is little known and is not readily recognized by the average operator. These ores also contain varying amounts of lead carbonate and lead sulphate, and attempts to effect their recovery were based on the assumption that the lead content was present as lead carbonate and lead sulphate. In consequence, the treatment applied was based on the utilization of the higher gravity possessed by these two minerals and the possibility of utilizing sulphidizing agents and effecting their recovery by flotation. Results obtained by this type of treatment were poor and in no instance did they comply with the requirements of commercial practice. Failure to secure the desired results in this particular operation was due primarily to the presence of a mineral whose existence had not been known. Furthermore, silver losses in the type of ore described had always been much higher than those of the lead and could be directly traced to the existence of argentojarosite, a mineral that was thought to be of rare occurrence.

The investigation carried on by the Bureau established the fact that both plumbojarosite and argentojarosite are of relatively common occurrence and exist in abundance in ores of some localities. This work shows emphatically the necessity for a microscopic study of oxidized lead ores prior to treatment, to establish a knowledge of the mineralogy of the ore. It also indicates that the ores of lead containing large amounts of plumbojarosite and argentojarosite are not amenable to treatment by either gravity or flotation methods.

In an examination of a complex ore that has just recently been completed, the microscope showed that slightly finer grinding would liberate a considerably greater portion of the locked lead and zinc minerals. Tests made on this ore following the information gained from the microscope resulted in the reduction of the 15 per cent zinc content in the lead concentrate to 6 per cent, and also lowered the lead content of the zinc concentrate from 3.5 per cent to 2 per cent. Putting this procedure into actual mill practice will result in a material saving to the operating company, will eliminate the penalty for zinc in the lead concentrate, and also lessen the waste of zinc.

A careful study was also made of tailings from one of the Utah Copper Company's mills to determine the percentage of each copper mineral that was being lost in the tailings. This work involved the microscopic examination and measurement of about 30,000 individual mineral particles, but resulted in data that have been of great value to the company in its milling operations.

The Dividend terminal of aërial tramway nearing completion

North Lily to Increase Production Soon

ERECTION of surface structures is being pushed at the North Lily property, in the Tintic district, in Utah, so that regular operations on an increased basis may be started early in May. Underground development is proceeding at the same time between the 600 and 900 levels, where considerable drifting and raising is being done preparatory to stoping.

The large Nordberg electric hoist, serving the 65-ft. steel headframe and 900-ft. four-compartment shaft, is in operation, and the installation of the Ingersoll-Rand compressor unit has been completed. Rapid progress is also being made on the 2,800-ft. aërial tramway connecting the 400-ton capacity loading pockets at the shaft with the shipping terminal on the D. R. G. & W. spur at Dividend. This tramway will have a capacity of 50 tons an hour and will be supported by eleven intermediate towers. Ore will be conveyed from Dividend in steel cars of 70 tons' capacity to the Tooele plant of the International Smelting Company for milling and smelting.

Surface buildings near the shaft include the hoist and compressor house, a roomy and up-to-date change house, a two-story office building, a warehouse, and blacksmith and carpenter shops. An area south of the shaft is being graded for the erection of employees' residences.

To date about 32,000 tons of high-grade lead-silver ore containing some gold has been mined on the property and hoisted through the shaft of the adjoining Tintic Standard mine. Operations at the North Lily are in charge of J. S. Finlay, mine superintendent.

The 65-ft. steel headframe from rear of the change house. The 400-ton storage bins and terminal of aërial tramway are beyond headframe.

Quicksilver Producers Take Over Oregon Property

The Force quicksilver mine, near Gold Hill, Ore., has been taken over by a Washington corporation known as the Quicksilver Producers. A 100-ton capacity modern rotary furnace will be erected on the property, which consists of nine mining claims. It was operated before the war.

Report to Commonwealth Club Favors Hydraulic Mining in California

Commission Appointed to Investigate Believes Riches Can Be Extracted From the Sierras Without Injury to Agriculture

ON APRIL 19, 1928, Walter Stalder, chairman of the section on mineral resources of the Commonwealth Club of San Francisco, reported the results of an investigation to determine facts about the improvement of hydraulic mining in California. The investigation was begun in the fall of 1927, and many phases of the problem were examined. Both Mr. Stalder and his associations have rendered an important public service. The report which was presented at the regular meeting of the club is as follows:

To the Board of Governors,
Commonwealth Club of California.

Careful consideration of the papers presented on the question of resumption of hydraulic mining in California and of the discussion thereon leads your section and sub-section on Mineral Resources to present the following conclusions:

That it is to the interest of the state to render possible the recovery of at least a considerable percentage of the gold remaining in the gravels of the Sierras, provided this can be done without prejudice to the interests of the farmers and others in the valleys, or to the public interest in maintaining the rivers in a navigable condition. The resolution of the section on Harbor Development effectively clears the latter proviso, and we think that it has been well established during the course of our discussions that the débris can, within limitations prescribed by the Débris Commission, be stored behind dams of modern construction. The contention of the opponents to rehabilitation that material other than natural erosion products will pass over the crest of such a dam after the remaining storage has filled with such natural erosion products, we think is erroneous and untenable.

The benefits arising from the limited and regulated resumption of hydraulic mining are general: The miner will benefit directly to the extent of his possible profits from operation, to which he is entitled. The farmer will benefit, for a temporary period at least, by the storage of the natural erosion products, which otherwise pass unimpeded during flood periods, and in addition the farmer, in common with other lines of business, will benefit from the increased market created. Labor will benefit, as will the community at large, by increasing employment, and the commonwealth will benefit by the addition to the nation's wealth. It seems inconceivable that all this potential wealth should continue to be locked up indefinitely in the hills. There seems, therefore, to be a community of interest that will justify the state in aiding, at least to the extent of standing the cost of engineering investigations, in order to assist in putting this industry back on its feet.

Much of the argument of the opponents has been directed toward attempting to show that hydraulic mining cannot be carried on at a profit (though this argument is illogically coupled with the expressed fear that if once started it will never be stopped until all the available gravel is washed). It seems to us that this is a matter for the miner to determine. It has been conclusively shown that there are large bodies of gravel already stripped which can be effectively washed by modern methods at a profit, given a sufficient water supply and provided cost of storage of tailings is not excessive. It is evident, however, that storage cannot be provided by construction of dams for this purpose alone. Otherwise, such dams would have been built already, under the provisions of the Caminetti Act.

This leads us to a consideration of the various purposes a dam may serve. In the case of water storage a constant head is not maintained, and the draw-off is from the bottom. Such a dam provides a reservoir of water which can be utilized as needed, either for power or merely for flood control, by turning the water back into the channel to empty the reservoir. Most of the dams already built in the Sierras serve one or more of these purposes, and dams built in the future primarily for flood control would be of this same general purpose.

Now, it is manifest that débris cannot be stored behind such a dam without defeating the purpose for which it is built: The storage would be reduced and the operation endangered.

The Bullard's Bar dam was built with an entirely different purpose in view—viz.: to supply water under constant head for power purposes, and to sell débris storage behind it in order to minimize the investment. Such a dam must be kept full to serve its purpose, and serves no purpose of water storage or flood regulation, as the flow over the top is always that of the normal flow of the stream. It is with this type of service that we are concerned. A combination of the two types is of course possible, in which the lower portion serves for débris storage and the upper for water storage, with the draw-off at or near the bottom of the upper portion.

Now, the total available storage in the canyons of the Sierras is limited. It has been estimated that were the entire capacity utilized for flood control it would at best take care of about one-seventh of the mean annual runoff. The question for the people of California to decide is how the remaining storage capacity can best be used to their greatest benefit. This question is too large for this committee to attempt to decide.

One of the points stressed by the proponents of rehabilitation is that some at least of the hydraulic pits will ultimately serve for water storage to an extent at least equivalent to the stream storage used. Such storage will be of more permanent value than the equivalent stream storage could possibly be, as it provides for storage of waste waters that otherwise will be lost in run-off, with no filling up by products of natural erosion. These waters will be made available for use both for power and subsequently for irrigation at a period of scarcity. A double duty can thus be secured for power purposes, as not only will the height above the stream be utilized in available head, but the water thus freed will be used again at the dam for additional power, and at lower levels for irrigation, thus benefiting everyone concerned.

It seems to us that the solution lies in the development of these projects by private enterprise in those areas where the holdings or consolidations are of sufficient size, and which possess financial ability to do so, along similar lines to those under which the Bullard's Bar dam was constructed, in which both power and débris storage are the considerations. In those areas, however, where there is a multiplicity of ownerships, we recommend that the state and/or federal government can justifiably and should assist in the engineering investigations and possibly in the building of such dams. Review by most eminent legal talent is to the effect that governmental participations will not impair the right of injunction by anyone who may be injured by such operations. In either case, private or governmental construction, the project would be under the jurisdiction and regulation of the California Débris Commission under the authority of the Caminetti Act as contemplated in that act.

Regarding plans for financing, it is likely that with those projects which can be developed by private capital with a view to power development primarily and of débris storage secondarily, there will be no need to ask for governmental aid in building the necessary dams, but for other projects it is suggested as a financial solution of the problem that when a hydraulic miner or a group of hydraulic miners can demonstrate to the California Débris Commission by satisfactory business guarantees with reputable power purchasers for water power and (or) irrigationists for water and (or) a fair charge for storing hydraulic mining débris, that a dam for hydraulic mining débris and these or other accessory purposes will amortize itself in 25 years with

Atlas Mining to Resume Work in Crosscut Tunnel

ATLAS MINING, of Wallace, Idaho, is preparing to resume operations in the long crosscut tunnel near Mullan, which the company completed last year. This tunnel is 7,000 ft. long. The Atlas property is a consolidation of the Carbonate Hill, Idaho Giant, Boulder Creek, and Horseshoe properties, all of which had been more or less developed. On the Carbonate Hill a very promising showing of lead-silver ore had been found drifting from the bottom of a shaft 400 ft. deep, this work having been done under the management of W. Earl Greenough, mining engineer, and it was through Mr. Greenough that the Atlas consolidation was subsequently effected and the long crosscut driven. The most important disclosure in the crosscut was the Carbonate Hill vein, which was intersected about 3,000 ft. west of the Carbonate Hill shaft. The purpose now is to drift east or toward the Carbonate Hill shaft on this vein, which will explore it at considerable depth below the bottom of the shaft.

interest at 5 per cent, then the United States government advance all funds for the purpose of constructing such dams. It is suggested further that all such funds be derived from royalties from United States government lands in the State of California, accruing or accrued under the provisions of the mineral leasing act of Feb. 25, 1920. All funds so provided are suggested to be considered as appropriations by Congress to fulfill the provisions of the Caminetti Act of 1893. Respectfully submitted, WALTER STALDER, chairman; WALTER W. BRADLEY, J. W. CROSBY, ABBOT A. HANKS.

Otto von Geldern, representative of the Sutter County agriculturists, presented a report in opposition, in which he requested that the Mineral Resources Section do not commit itself to the committee's report (quoted before). He claimed that hydraulic mining in limited quantities cannot be made profitable, if the sponsors of rehabilitation have to bear the burden of the cost of restraining the débris. He objected to subsidized hydraulic mining. Referring to the proposed Narrows dam, he stated that it would be ultimately filled with débris and any further contribution must run over the dam. He advocated reserving the Narrows dam for water storage, and said: "The main point at issue to which the argument had sifted before this section is whether the enterprise is financially sound. If not, it should not be recommended by the committee. We take the position that hydraulic mining should not be subsidized."

Abbot Hanks on behalf of the committee reviewed the historic status of hydraulic mining and showed how the mineral industry through the proceeds derived under the federal leasing system was making large financial returns to the State of California and that from such funds direct aid to the mining industry should come.

J. D. Stewart made a strong argument for the hydraulic miner. Otto von Geldern argued for the agriculturists. R. T. Develin spoke of the undying opposition of the agriculturists and the "slickens" problem. C. M. Eye expressed the opinion that co-operation of agriculturist, miner, and power interests would be mutually advantageous. A. H. Hewitt said that the term hydraulic mining has no charm for any agriculturist or horticulturist in the Sacramento Valley. Lloyd L. Root, state mineralogist, spoke for the miners. William Hann Hall urged a restrained policy. C. A. Worden espoused the agriculturists. H. C. Cloudman made a plea for the miner, and C. E. Grunsky spoke in the interests of the general public. The meeting was attended by about 125, among whom were many mining men, several engineers, and others from agricultural sections.

Empire Zinc Will Build Mill in Red Cliff District

IT IS reported that Empire Zinc will build a new mill in the Red Cliff district of Colorado to replace the mill that was destroyed by fire last year. The men engaged in the mill have been used in development work, which has resulted in the blocking out of sufficient ore to feed a mill for a considerable period. Empire Zinc is controlled by New Jersey Zinc.

Wolf Tongue Mining, a tungsten producer in the Boulder district, started a mill of 25 tons' capacity on April 25. It supplants the old mill that burnt last year.

Golden Cycle Mining & Reduction has found it necessary to add to its present mill building at Colorado Springs. The remodeling will cost about $50,000.

Mayflower-Old Colony Is Driving Long Crosscut at 1,700 Level

AT Mayflower-Old Colony the exploratory crosscut, at a depth of 1,700 ft., is opening a territory in which no previous work has been done. The project is considered highly important for this reason. The area is extensive, and it is believed that a lode of commercial value will be found. Already the crosscut is 3,500 ft. from the shaft. To date, a number of lodes have been cut, but none has carried copper in commercial quantity. The crosscut will open the wide belt between the St. Louis amygdaloid and the Kearsarge lode. Work is being economically pushed, as the drift requires no timbering. No fault conditions have been encountered, the strike and dip of all beds cut during the past year have been normal in geologic structure.

Enrichment in copper with depth in the Quincy mine now is being shown to the north of No. 6 shaft in the 87 or bottom level. The main Pewabic vein, which recently was cut, is heavy in copper the full dimensions of the drift, top, bottom and sides. The lode is wider than usual, the drift being approximately 7½x7½ ft. The drift may be the top of a new and highly important enrichment. Main lode at this point shows the same characteristics of enrichment found in the East lode in the bottom of No. 2 shaft.

This is said to be the first time in the long career of Quincy that the Main vein has evidenced such a pronounced change in copper content, and the widening formation also is considered highly significant. The Pewabic bed has been increasing in copper content with depth.

Tamarack & Custer to Abandon Its Mill on Canyon Creek for Hercules Mill

TAMARACK & CUSTER, operating the Tamarack mine, in the Coeur d'Alene district, will soon divert its ore from the Tamarack mill to the Hercules mill, at Wallace, Idaho. At present, the outlet of the mine is at the head of Nine Mile Canyon and the mill is on Canyon Creek. Ore is delivered to the mill by a cable tramway, two miles long. Recently, in the course of development between the Mammoth tunnel, which opens on Canyon Creek, and the upper workings, a new oreshoot was discovered which has been proved to contain sufficient ore to assure a prolonged life for the mine. Connections are now being made between the lower and upper workings with a view to making the Mammoth tunnel the permanent operating outlet, thus enabling the abandonment of the long tramway. Delivery of ore from the opening of Mammoth tunnel to the Tamarack mill, however, would require the construction of a railroad high line up to the bins, an expensive undertaking. As the Hercules mill at Wallace, 5 miles away, is not operating at capacity, the management evidently decided that it would be more satisfactory to send the ore to that plant rather than incur the expense required to deliver to the Tamarack mill. Both the Tamarack and Hercules companies are controlled by the Day interests.

Tamarack & Custer's mill, in the Coeur d'Alene district

New York Section, A.I.M.E., Hears Professor Taggart Discuss Flotation

PROF. A. F. TAGGART, of Columbia University, spoke on "Flotation Fundamentals," at the April meeting of the New York Section, A.I.M.E., held Wednesday evening, April 25, at the Machinery Club. The size of the audience indicated the timeliness of the subject as well as the popularity of the speaker.

Professor Taggart attacked his subject in direct and logical fashion. Beginning with the early experiments of Elmore, he outlined the nature of the phenomena observed in each of the basic stages of progress in the flotation process. With the aid of a few blackboard sketches, Professor Taggart advanced an explanation of the various flotation phenomena. The lifting force of the air bubble as affected by contaminants (flotation agents) in the bubble film, differential wetting of sulphide and gangue particles, the action of collecting and frothing agents, and other similar phenomena were included in the topics discussed. The value of the frothing agents was held to be a function of their solubility and their hydrocarbon content; and connection exists between the merit of a collecting agent and its relative insolubility, the inclusion in its formula of a reduced element, and a hydrocarbon. He explained that virtually all of the better-known collecting agents of the present time contain a low valence sulphur atom or a trivalent nitrogen atom, with a relatively insoluble hydrocarbon, but some success has been had in replacing the S or N atom with a selenium base; and experiments have been conducted with some other metal and semi-metal bases, with prospects of ultimate success. In connection with the action of the inorganic modifying compounds, less was said to be known than of the seemingly more complex organic chemical compounds. Professor Taggart expressed the belief that the action of the modifying agents could be largely attributed to their ability to modify or prevent the formation of slime coatings on the sulphide faces. Also, the rapidity with which sulphide minerals oxidize in water has not been fully appreciated. Perhaps the most difficult feature of the situation to explain satisfactorily is the contradictory effects secured by some of the better-known modifying agents, such as lime for example, in different ore pulps.

Chairman Sidney Rolle called on R. C. Canby, E. H. Robie, and J. M. Callow to discuss the subject. Mr. Canby stated that he had been a close follower of flotation for nearly twenty years, but after listening to Professor Taggart he felt as though he belonged in the beginners' class. E. H. Robie, associate editor of *Engineering and Mining Journal*, who recently visited the important flotation plants in the Southwest, promised that in future issues of the *Journal* he would have much to say regarding current practice. He mentioned the growing tendency in the larger operations to depend on delicate adjustments of alkalinity, and the new organic chemical reagents, in securing a higher degree of sulphide selectivity in their flotation operations.

J. M. Callow added to the discussion from a sentimental and emotional standpoint, as he expressed it, in preference to an attempt to add further comment to Professor Taggart's valuable contribution to the technology of the subject. Mr. Callow took exception to the decision of Justice Bourquin in the Metals Recovery vs. Anaconda patent litigation suit, with particular reference to that part of the decision quoted in the editorial in the April 7 issue of *E.&M.J.*, entitled "Minerals Separation Has a Touch of Adversity." In the opinion of Mr. Callow the work of Perkins was not given the credit it deserved by the Court in the above-mentioned case. Before Perkins, modern flotation was truly oil flotation; after Perkins, reagent or chemical flotation would be the more fitting designation, he argued.

Altogether the meeting was very enjoyable as well as instructive, although many of those present expected a more detailed discussion of the trend of actual operations in the field.

Mariposa County, Calif., May Witness Revival

AT A MEETING in New York two weeks ago, final details were carried out in the organization of the Fremont Grant, Inc., a Nevada corporation which owns all the property of the old Mariposa Estates, in Mariposa County, Calif. This old property is situated on what is known as the southern portion of the Mother Lode. Development of the mineral prospects on the property will be under the charge of Dwight E. Woodbridge, of Duluth, Minn., who has been retained as directing engineer.

Mariposa Estates has had a long and interesting career. Originally a "float" grant from the government of Mexico to its last administrator of the province of Alta California, it was purchased by General John C. Fremont about the time of the brief independence of California. In 1856 Fremont had decided just what lands he wished to inclose within the boundaries of the 74 square miles contained in this grant, and received a United States patent to the tract, including 12 miles along the Mother Lode. The presence of thousands of placer miners washing out gold no doubt assisted the general in his selection. With the aid of United States troops, he was able to evict an army of them.

For a long time mining was carried on extensively, although the owners of the grant changed frequently. About $20,000,000, it is estimated, is the value of the gold extracted from the producing mines. The Princeton mine was operated to the depth of 1,600 ft., and at that depth it was still in ore. Altogether is is said there are not fewer than 60 different locations on the grant where ore of commercial quantity has been worked.

Most of the mines have been idle for many years. Fremont Grant will reopen some old and gradually develop new deposits.

Continued Activity at Hyder Results From Stock Boom

CONTINUED ACTIVITY is noted near Hyder, Alaska, in the Portland Canal district, partly as a result of the boom in mining stocks in Vancouver and Victoria, B. C. Amalgamated Mines, Ltd., has been organized in Vancouver to take over and develop the holdings of Hyder Lead Mines, which consist of the Alaska Comstock group. Lead and silver, with some zinc, are the metals present in the ore. The Border and Virginia groups, on Salmon River, have been acquired by Winnipeg interests. Another Hyder company, Titian Gold Mining, is starting active development of the ten claims that compose the property. Gold and silver occur in the ore.

H. W. Watson, of Juneau, has purchased a plant with which to develop his placer holdings at the junction of Montana and McGinnis creeks, in the Eagle River district. The ground will be tested for dredging.

A three-stamp mill is being installed at the gold-quartz property of Clyde Brenner, in the Turnagain district, Kenai Peninsula. The gold is said to be free-milling. The new mill of the Ethel mine, on Mineral Creek, west of Valdez, is expected to be in operation by June.

Blasting Powder Accidentally Kills Man at Mond Nickel

Joseph Doni was killed instantly and Hurkart Haryzuki was severely injured on April 26 when a bag of blasting powder accidentally exploded at the Levack mine of the Mond Nickel Company, in the Sudbury district of northern Ontario. The men had just ignited a fuse on the 700 level and retired to what they considered a safe distance when the bag of powder was exploded in some unexplainable manner. They were hurled a distance of more than 30 ft., and were caught under a large rock which had been dislodged. Haryzuki is expected to recover.

Fairbanks Exploration Ships Third Dredge

Parts for the third dredge constructed for Fairbanks Exploration by the Bethlehem Shipbuilding Corporation were shipped to Alaska from San Francisco on April 20. The dredge will be erected on Goldstream Creek, in the Fairbanks (Alaska) district. It is expected that the two dredges now under construction will be ready for operation in July and there will be a sufficient working season to begin operations.

Johannesburg Letter

By Owen Letcher
Special Correspondent

Postmasburg Manganese Field, With High-Grade Ores, Elicits Attention

Johannesburg, March 28, 1928—Several companies and syndicates have been formed in Johannesburg to acquire and operate the manganese deposits of Postmasburg, in the Cape Province. One of the big mining companies of the Rand, the Consolidated Goldfields, some time ago secured an option over one of the properties in the district, but did not exercise it. It is generally assumed that the absence of railway facilities—there are none within 100 miles of the district—has been the greatest obstacle.

Within the last week or two, however, a more favorable future for the field has appeared by reason of the submission of a draft railway agreement and the visit of two well-known iron and steel authorities, Charles P. Perin, of Perin & Marshall, New York, and R. A. F. Chantrein, a Belgian consulting engineer. Mr. Chantrein visited the property of the Gamagara Manganese Corporation on behalf of an important Belgian group which holds an option on the property. Satisfactory reports on this property have already been made by Sir Robert Kotze, former Government Mining Engineer. On the farm Klipfontein, belonging to the Gamagara company, a 9-mile stretch of high-grade manganese has been opened up by nine shafts sunk to an average depth of 14 ft. This deposit is on the projected line of the railroad and is favorably situated for early developments.

THE QUESTION of transportation is all important. It is considered probable that the Union government may enter the field itself. The government appears intent on establishing a steel industry under government control, in which event it might desire to develop the Postmasburg ores for use as an alloy. R. O. Nel, a member of the geological survey, has been on an official visit to the fields on behalf of the government and the Gamagara company. A form of draft agreement has been submitted by the general manager of the South African Railways to all the manganese companies, which would guarantee a certain tonnage of ore for the proposed railroad.

One of the most serious crimes in South Africa is the selling or possession, without a license, of unwrought gold. This is commonly known as illicit gold buying—or "I. G. B." The fact that it is still practised, despite all precautions, has been revealed by a sensational theft of gold from the Sub Nigel mine and the detection of the criminal. The provision of locked screens over amalgam plates and corduroys has greatly reduced pilfering recently, but that "I. G. B." is still indulged in is evident. One method of disposing of illicit gold is to acquire a small mine somewhere in a remote district. Probably the mine in question proved a distinct failure under previous owners. The new syndicate, however, steps in, and almost immediately produces quite astonishing quantities of gold. Usually this gold comes originally from the Main Reef series and not from the mine, which may be situated hundreds of miles from Johannesburg.

The use of flotation for the ores of the Murchison Range, in northern Transvaal, is understood to be under consideration. These antimonial, auriferous ores of the Murchison have from time to time produced substantial quantities of gold, but production has not been steady, because of the metallurgical difficulties. In southern Rhodesia Cam & Motor gold mine has made a distinct success of the treatment of ores containing gold in association with antimony.

Mexico City Letter

By W. L. Vail
Special Correspondent

Railroad Building Increases Exploration Work in Northern Chihuahua

Mexico City, April 23, 1928.—The opening of the Kansas City, Mexico & Orient Railroad from Marquez to the Rio Grande, at Ojinaga, Chihuahua, in the early summer is stimulating exploration work in the northeastern part of that state. Plans have been made to continue construction to Alpine, Tex., where the road will connect with existing lines. Several concessions have been applied for to work old placer grounds. A group of New Orleans promoters has recently taken over the old Lepanto mine, and expectations are that operations will be resumed soon.

The latest report to the stockholders of La Borda Antigua is not very encouraging. With the exception of the Carmen de Virgenes vein, it is reported that this property, near Tlalpujahua, Michoacan, is exhausted. Since 1912 the Borda mines have produced 204,000 tons of ore, valued at 4,308,782 pesos. More than 900,000 pesos was spent in the same period in exploration.

A new mining zone has recently been opened at Campos, in the Moctezuma district, Sonora, and an automobile road for tractors is being constructed into the heart of the new field.

The Cia. Minera Explotadora y Beneficiadora de Guanajuato, one of the largest concerns in that important camp, has notified the authorities of its inability to continue operations without loss under present conditions. The usual permission will probably be granted, as it is evident the application for closure is well grounded.

London Letter

By W. A. Doman
Special Correspondent

Tin Interests Hope to Raise Price of the Metal by Propaganda

London, April 17, 1928.—There is renewed interest in the tin market, both as regards the metal and the shares of the producing companies. Those who desire a higher price, and if possible a stabilized price, are trying to draw attention to the uses of the metal. It is pointed out that there is no substitute for tin, and they are trying to stimulate its uses by propaganda of the style used in America in connection with copper and brass. I understand that a tin exhibition will soon be held at the Royal Horticultural Hall. John Howeson is again trying to arrange some kind of control or co-operation among the various producers of tin in the British Empire.

The $20 shares of the Patiño Mines & Enterprises Consolidated, a company incorporated under the laws of the State of Delaware, have been introduced to the London market at about £5 15s., it being stated that the total area of mining properties owned at Dec. 31, 1926, was 8,721 acres. The ore reserves at Dec. 31 last are given as 1,231,091 metric tons, assaying 4.74 per cent, equal to 58,346 tons of fine tin. The average cost, not including depreciation, per long ton of fine tin last year was £148 per ton, and the average sale price £261 14s.

REPORT of the Chemical & Metallurgical Corporation, Ltd., for 1927 has just been issued. Despite unfavorable weather last year, good progress has been made with the erection of the company's works on the Manchester Ship Canal, the first unit, the hydrochloric acid plant, working throughout the year without interruption. The second unit, the roasting furnaces and sulphuric acid plant, is virtually complete, and will be in operation in a few weeks' time. Remaining units of the plant are under construction. The first portion of the platinum-copper-nickel plant is nearing completion and will be brought into operation soon. The company has been working a pilot plant at the Stratford Works and has obtained high recoveries of platinum-copper-nickel at low costs. Prof. J. G. Lawn, representing the Barnato group, has been elected to the board of directors of the corporation.

Several weeks ago I mentioned the platinum deposits in Sierra Leone, discovered in May, 1926, by the Director of the Geological Survey, Major N. R. Junner. His recent investigation enabled him to state that the platinum-bearing area is about 40 square miles in extent, and that the deposits, which are alluvial, are likely to be of considerable importance.

Personal Notes

A. G. MACKENZIE, of Salt Lake City, was in New York recently.

CORNELIUS F. KELLEY left for Europe on April 28 on the "Olympic."

J. A. FROHOCK, vice-president and managing director of the Crystal Copper Company, recently visited Montana.

F. J. DAY and C. W. NEWTON have been elected to the board of directors of Montana-Idaho Mines Corporation.

W. OSGOOD, assistant state geologist of Michigan, recently visited Wallace, Idaho, to examine mining properties there.

J. CLAIR EVANS, of Denver, vice-president of the Denver Fire Clay Company, is in New York on a short business trip.

HAROLD L. PHILLIPS, an English mining engineer, is now in charge of the development of the Empress mine, in Arizona.

SYDNEY H. BALL, of the firm of Rogers, Mayer & Ball, of New York, has left for a month's professional trip in Canada.

RALF R. WOOLLEY, of the U. S. Geological Survey, Salt Lake City, has been ordered to Washington, D. C., for several months.

DAVID DRAPER, consulting geologist in the Transvaal, recently received the honorary degree of doctor of science from Witwatersrand University.

VERNON L. MATTSON, mining engineer with Norrie & Tower, visited New York recently after a professional trip through the South Atlantic states.

B. W. DYER and J. J. BOURQUIN, of the Conservation Branch, U. S. Geological Survey, Salt Lake City, are on a month's trip inspecting properties in Arizona.

A. L. LABBE, metallurgical engineer of American Smelting & Refining, left Salt Lake City on April 23 to spend three weeks at the El Paso (Tex.) plant of the company.

B. B. THAYER, vice-president of Anaconda Copper, recently inspected the company's workings in Montana, and will probably go to Utah before returning to the East.

W. B. DALY, general manager of mines of Anaconda Copper at Butte, is taking a month's vacation, visiting the larger cities of the East, Middle West, and South.

L. S. CATES, vice-president and general manager of Utah Copper, returned to his Salt Lake City headquarters on April 28 from a month's business trip to New York City.

JACK CAMPBELL has been engaged to take charge of active development at the claims of the Ramon Gold Mining Syndicate in the Cold Lake district of northern Manitoba.

N. H. JENSEN, of the ore-purchasing department of the International Smelting Company, has returned to his Salt Lake City headquarters from a trip through the Southwest.

CHARLES MCCREA, Ontario Minister of Mines, addressed the annual meeting of the Winnipeg Board of Trade on April 20. He described the mining laws of Ontario in detail.

STANLY A. EASTON, of Kellogg, Idaho, vice-president and manager of the Bunker Hill & Sullivan Mining & Concentrating Company has been elected one of the eleven delegates to represent Idaho at the national Republican Convention at Kansas City on June 12.

STANLY A. EASTON

CHARLES LABBE, who for some time has been connected with the mechanical department of the United Verde Copper Company, recently left for Death Valley Junction, Calif., where he owns a mining property.

ALLAN J. ANDERSON, who superintended the operations of United Verde Extension at Rouyn before Mining Corporation of Canada took over the claims, is now manager of the properties of Amulet Mines, Ltd.

HENRY T. LONG is retiring from partnership in the firm of Lewis Lazarus & Sons, of London. This firm has recently formed an American branch to be known as Lewis Lazarus & Sons, of New York, Inc.

J. EDWARD BERG, mining engineer and assistant superintendent of the Morning mine, in the Coeur d'Alene district, has recently been appointed superintendent of the Page mine. Both mines are owned by Federal Mining & Smelting.

WARD A. MILLER has been appointed vice-president of the Vanadium Corporation of America. He was formerly New York sales manager of Midvale Company, of Philadelphia, in charge of the district comprising New York, New England, and Canada.

DR. J. E. HAWLEY is in charge of the survey of the Sepawe Lake area, one of ten geological parties sent out by the Ontario Department of Mines. DR. E. M. BURWASH is to investigate the Fort Hope area, on the Albany River, and DR. W. S. DYER will have charge of investigations along the Moose River.

WILLIAM F. HAYDEN, consulting mining engineer, is recuperating at his home in Salt Lake City from injuries received in an automobile accident recently. At the time of the accident Mr. Hayden was en route to Phoenix, Ariz., from the Twin Peaks mine, near Wilcox, Ariz., which he had been examining.

W. H. EARDLEY, assistant manager of United States Smelting, Refining & Mining, delivered a lecture on ore buying before the mining students of the University of Utah on April 21. C. A. LEMKE, assistant superintendent of the company's Midvale plant, gave a talk on ore concentration before the same group on April 28.

CARL HAYDEN, recently elected to the Senate from Arizona, has been made a member of the Mines and Mining Committee. Senator Hayden was born in Arizona and has kept in close contact with copper mining, the basic industry of his state. He was one of those who negotiated a settlement of the differences between the copper producers and the Bureau of Internal Revenue in regard to the regulations governing the calculation of taxes.

WALTER A. RUKEYSER, consulting and mining engineer of New York City, has just returned from the Southwest, where he supervised the construction of two reduction plants in Arizona and California. Mr. RuKeyser was recently appointed special lecturer in the department of geology, Princeton University.

CYRIL W. KNIGHT, formerly of the Ontario Geological Survey and for several years geologist of Nipissing Mining, recently resigned from the Nipissing company and has organized a company called Cyril Knight Prospecting, Ltd. The directors of the company include FRASER D. REID, manager of Coniagas Mines; H. C. MCCLOSKEY, formerly manager of McKinely-Darragh; Mr. Knight, and JAMES RICHARDSON, of Winnipeg. The company will conduct exploration work, chiefly in the Patricia, northern Manitoba, and Northwest Territory mining fields.

OBITUARY

VERNON S. ROOD, general manager of Utah Apex Mining at Bingham, Utah, died at Saranac Lake on May 1.

AUSTIN JOHN ATKIN, who had charge of important mining ventilation work in South Africa, died in Johannesburg on March 23. Mr. Atkin had been engaged in mining in British Columbia, Western Australia, and the Rand.

Market and Financial News

Treadwell Yukon Is Nucleus of an Important Group of Mining Companies

Bunker Hill & Sullivan, Alaska Treadwell, Alaska United, and Alaska Mexican Own Stock of the Holding Corporation, Which Controls Properties in Sudbury, Yukon, and Nevada

FINANCIAL connections, as of Dec. 31, 1927, among the Treadwell Yukon Company, Ltd., the Bunker Hill & Sullivan Mining & Concentrating Company, the Alaska Treadwell, the Alaska Mexican, and the Alaska United Gold Mining companies are as follows:

The Treadwell Yukon Company, Ltd., has 1,500,000 common shares, par value $1, issued, or $1,500,000 outstanding; 100,000 preferred cumulative shares authorized but unissued. It is in debt to the following important amounts and to the following companies:

Bunker Hill & Sullivan M. & C. Co.	$1,285,731
Alaska Treadwell Gold Mining Co.	907,665
Alaska Mexican Gold Mining Co.	80,407
Total	$2,273,804

Bunker Hill & Sullivan Mining & Concentrating Company has advanced $1,279,849 to Treadwell Yukon and, in addition, owns a 50 per cent interest in this company, which is carried on its books at $749,988.

Alaska Treadwell Gold Mining Company has an excess of assets over liabilities amounting to $1,967,146, exclusive of property, plant and 60 per cent interest in joint utilities and Shaken (molybdenum) property. It owns common stock in Treadwell Yukon to the amount of $449,992, less liquidating dividend (120,000 shares), or $120,000, or, net, $329,992 (book value, 330,000 shares).

The Alaska Mexican Gold Mining Company has an excess of assets over liabilities of $202,319, exclusive of property, plant, and 20 per cent interest in joint utilities and Shaken. It owns common stock of Treadwell Yukon to the amount of $149,997, less liquidating dividend of 36,000 shares, or $36,000, leaving net of $113,997 (book value, 114,000 shares).

Alaska United Gold Mining Company has an excess of liabilities over assets of $135,294, exclusive of property, plant, and 20 per cent interest in joint utilities and Shaken. It owns $149,997 (book value) worth of Treadwell Yukon stock —148,225 shares—and owes Alaska Treadwell $288,170. against which Alaska Treadwell paid $600,000 liquidating dividends in cash and 120,000 shares of Treadwell Yukon stock, of a market value of about $3,000,000. Alaska Mexican paid liquidating dividend of 36,000 shares Treadwell Yukon stock, of a market value of about $900,000.

The properties of the Alaska Treadwell, Alaska Mexican, and Alaska United are in process of liquidation. Power plants owned in common by the three companies are to be transferred to Alaska Juneau in return for a stock interest in that company. The exact basis of the transaction has not yet been announced. The three companies have a stock interest of $593,987 (book value, 592,225 shares) in Treadwell Yukon, and have owing to them by the same company $988,073, or a total of $1,582,060.

Of the joint utilities Alaska Treadwell owns 60 per cent; Alaska Mexican, 20 per cent, and Alaska United, 20 per cent. The original capitalization of the three companies was: Alaska Treadwell, $5,000,000, $25 par; Alaska Mexican, $1,000,000, $5 par (180,000 issued); and Alaska United, $1,000,000, $5 par (180,200 issued). Up to April, 1917, the three companies had mined from the Douglas Island properties 27,163,473 tons, earned profits of $25,357,659, and paid dividends of $21,337,651. The flooding of the mines on April 21, 1917, caused the cessation of mining in all except the Ready Bullion, which continued until 1922. In 1920 the three companies joined with Bunker Hill & Sullivan in forming the Treadwell Yukon Company, Ltd., to conduct prospecting and mining operations, the proportional interest being Bunker Hill and Sullivan, 50 per cent; Alaska Treadwell, 30 per cent; Alaska Mexican, 10 per cent; and Alaska United, 10 per cent. This was a continuation of a similar participation of these four companies in the ownership of the Tacoma Smelter in 1898, which ownership continued until the Tacoma smelter was sold in 1905 to the American Smelting & Refining Company. Capitalization of Bunker Hill & Sullivan is 327,000 common (all issued) at $10 par and 20,000 shares of preferred, $100 par, of which 6,393 shares have been issued.

The principal properties of Treadwell Yukon are the Wernecke mines, at Mayo, Y. T., together with other properties in the same region; the Tybo properties, in Nevada; and the Errington mines near Sudbury, Ontario, Canada. The Mayo properties are producing, the Tybo has been developed and a 200-ton mill is to be erected; the Sudbury property is being developed and the 200-ton mill is about ready for operation. The annual report of 1927 shows a deficit for the year of $172,222. which, added to the previous year's deficit, makes a total deficit of $339,594. The Wernecke mine showed a net profit of $279,368 before depreciation, depletion, income tax, and adjustments and after these deductions a loss for 1927 of $5,299. Net deficit after adjustments was $3,818. The financial position is what might be expected, as the properties are, with the exception of the Wernecke, in the early stages of operation where large expenditures are necessary for development, operation, research, plant construction, and the necessary accessories. A computation of ownership was made in 1927, and this appears to be as follows: 50 per cent (750,000 shares) by Bunker Hill & Sullivan; 22 per cent (330,000 shares) by Alaska Treadwell; 7.6 per cent (114,000 shares) by Alaska Mexican; 10 per cent (148,225 shares) by Alaska United, and 10.4 per cent (157,775 shares) by the public.

An Alaska Treadwell stockholder has participating interest in stock owned by his company equivalent to 1.65 shares of Treadwell Yukon for each share of his stock; Alaska Mexican, 0.633 shares of Treadwell Yukon for each share of Alaska Mexican stock, and Alaska United, 0.823 shares of Treadwell Yukon for each share of Alaska United, but in the last named the company's indebtedness is to be liquidated before its shareholders receive Treadwell Yukon stock. Bunker Hill & Sullivan stockholders own 2.25 shares of Treadwell Yukon for each share of Bunker Hill & Sullivan, but this stock has not been distributed and will be held intact in the treasury of Bunker Hill & Sullivan.

Tennessee Copper & Chemical Reports Net Earnings of $408,498 in 1927

ANNUAL REPORT of the Tennessee Copper & Chemical Corporation shows net income of $408,498, equivalent to 51c. per share, in 1927. This compares with $1,089,617, or $1.37 a share, in 1926. Operations were curtailed appreciably because of the low price of copper. Production statistics compare as follows:

	1927	1926
Copper, lb.	11,063,234	12,566,665
Ore mined, tons	420,374	507,954
Ore smelted, tons	225,480	321,050
Ore milled, tons	194,775	181,580
60 deg. sulphuric acid, tons	291,393	354,722

During 1927, the Corporation purchased a controlling interest in the U. S. Phosphoric Products Corporation, which owns a triple-superphosphate plant of modern design, at Tampa, Fla.

Ore reserves at the Burra Burra and Eureka mines were estimated at 5,683,165 tons on Jan. 1, 1928, an increase of 8,588 during 1927. Mining costs were 4.6c. per ton lower, despite the smaller tonnage extracted.

The flotation plant handled an increased tonnage during the year, decreased milling costs, and yielded higher recoveries of copper and iron. The grade of concentrate produced was increased to 13.25 per cent copper at the end of the year.

St. John del Rey Earned £68,586 in 1927

ST. JOHN del Rey Mining Company, operating the Morro Velho mine, in Brazil, reported an operating income of £68,586 during 1927, before depreciation and depletion.

The output as compared with that of the preceding year shows an increase of 9,000 long tons crushed but a decline in the yield of 3s. 0½d. per ton. Working cost per ton is less by 5s. 3d., and a reduction in the tax on gold was made by the government of the State of Minas Geraes. Total ore reserve at the end of the year was 1,173,282 long tons.

The monthly return from the 140-stamp mill of the Morro Velho mine, in gold and silver, was as follows:

Date	Long Tons Raised	Long Tons Crushed	Refined Bullion Oitavas	Refined Bullion Ounces, Troy	Value of Gold
1927					
January	12,991	12,500	64,950	7,488.18	£31,598
February	12,146	11,800	61,646	7,107.37	30,000
March	13,742	13,200	71,926	8,292.63	34,999
April	10,178	10,000	49,321	5,686.29	23,998
May	13,465	13,000	64,720	7,461.73	31,498
June	12,408	12,000	61,644	7,107.09	29,997
July	12,618	12,200	65,741	7,579.51	31,999
August	12,337	12,000	63,361	7,304.99	30,798
September	12,340	12,000	71,966	8,297.25	34,999
October	13,635	13,400	73,160	8,434.86	35,599
November	13,596	13,300	71,818	8,280.12	34,943
December	13,731	13,500	63,589	7,331.58	30,948
	153,187	148,900	783,842	90,371.60	£381,376

Urofit-and-Loss Account to Dec. 31, 1927

Credit

Morro Velho working account balance	£68,586	14s.
Transfer and probate fees	64	4
Interest receipts	1,069	4
	£69,720	3s.
Balance brought forward	£60,287	8s.
Income tax	6,395	14
Balance brought forward at Jan. 1, 1927	42,847	12
	£109,530	15s.
London expenses	9,432	14
Balance carried forward	60,287	8
	£69,720	3s.
Capital works account Amount transferred	£15,000	0s.
Dividend payable April 20, 1928 10 per cent preference shares... £12,500 0 0		
Ordinary shares £40,969. 17 6		
	53,469	17
Balance carried forward	41,060	17
	£109,530	15s.

Asbestos Corporation Earned $695,126 in 1927

OPERATIONS of the Asbestos Corporation, Ltd., were continuous throughout 1927, and resulted in a net profit of $695,126, after allowing $300,000 for depreciation. Capital expenditures amounting to $533,649 were made, of which $206,214 was for new milling equipment at the Vimy Ridge property, $232,699 was for expenditures on the new Beaver mill, and $75,409 for the King's mine.

Statement of Profit and Loss for the Year Ended Dec. 31, 1927

Profits from operations for the year ended Dec. 31, 1927, after providing for dominion and provincial income tax, but before making provision for depreciation	$1,357,380
Interest on investments and bank deposits	107,314
	$1,464,694
Deduct bond interest	469,568
	$995,125
Deduct provision for depreciation	300,000
	$695,125
Deduct dividends on preferred stock	521,927
Surplus profits from operations for the year ended Dec. 31, 1927	$173,198
Add surplus at Dec. 31, 1926	205,228
Surplus profits as per balance sheet	$378,427

RAND MINES, LTD., reported a net income of £635,195 in 1927, against £645,227 in 1926.

Imports and Exports of Ores and Metals in March, 1927 and 1928

Compiled from U. S. Department of Commerce Records, In Pounds, Unless Otherwise Stated

Imports

	March 1927	March 1928
Antimony		
Ore { Gross weight	1,712,733	228,206
Ore { Antimony content	965,379	124,445
Liquated regulus or metal	2,270,496	1,726,218
Copper		
Ores, copper content	2,119,516	10,536,493
Concentrates, copper content	15,209,154	3,930,111
Regulus, coarse metal, cement copper	79,660	235,646
Imported from		
Spain	1,098,874	1,151,629
Canada	5,523,215	3,613,029
Mexico	2,781,050	4,052,073
Cuba	2,160,000	1,995,500
Chile	5,446,610	3,771,301
Peru	60,675	88,789
Other countries	337,906	29,929
Unrefined, black, blister, converter copper in pigs, bars, and other forms	40,121,645	29,963,179
Refined copper	17,927,908	4,314,758
Old and clippings for remanufacture	355,816	834,212
Composition metal, copper chief value	.....	.....
Brass, old, for remanufacture	865,102	877,280
Lead		
Ore and matte, lead content	6,010,026	3,975,599
Bullion or base bullion	21,489,978	21,128,919
Pigs and bars	1,390,183	8,863
Babbitt solder and other forms, lead content	106,878	90,482
Type metal, antimonial lead { Gross weight	11,293	1,139
Type metal, antimonial lead { Lead content	8,921	796
Manganese		
Cuba, manganese content	170	192
Other countries, manganese content	22,717	12,786
Pyrites, tons	27,832	46,612
Tin		
Ore, tons	12	6
Bars, blocks, pigs	13,319,272	18,229,787
Imported from:		
Netherlands	1,783,953	1,457,210
United Kingdom	2,463,327	3,041,059
British Malaya	8,323,581	12,583,231
Netherlands, East Indies	.....	137,193
Hongkong	117,011	259,749
Australia	134,400	256,400
Other countries	497,000	494,945
Zinc		
Ore, zinc content { Free	.....	.....
Ore, zinc content { Dutiable	1,772,220	192,980
Blocks, pigs, and old	1,524	.....

Exports

	March 1927	March 1928
Copper		
Ores, composition, concentrates, unrefined	620,063	379,846
Refined copper in ingots and other forms	80,029,368	83,076,505
Exported to		
Belgium	6,177,247	9,023,832
France	7,949,647	14,274,934
Germany	24,799,037	18,188,699
Italy	7,591,176	8,404,323
Netherlands	7,798,680	8,306,198
Spain	752,963	212,697
Sweden	2,356,970	2,064,553
United Kingdom	13,579,957	16,775,587
Other Europe	1,424,320	1,459,081
Canada	1,584,213	1,220,160
British India	100,800	1,204,348
China, Hongkong, Kwantung	607,040	1,115,267
Japan	4,871,222	746,118
Other countries	436,096	80,708
Old and scrap	4,071,848	5,448,987
Pipes and tubes	227,538	246,988
Plates and sheets	849,356	287,865
Rods	4,645,210	6,450,893
Wire	593,186	908,997
Insulated copper wire and cable	1,780,678	1,690,437
Lead		
In pigs, bars, and other forms	13,524,412	19,278,731
From domestic ore	80,322	218,198
From foreign ore	13,444,090	19,060,533
Exported to		
Belgium	672,151	.....
France	.....	2,464,748
Germany	4,088,772	2,632,905
Netherlands	224,069	1,064,275
Sweden	392,159	1,075,581
United Kingdom	4,033,272	6,274,243
Other Europe	225,135	560,214
Brazil	224,017	582,557
Other South America	136,815	67,183
China, Hongkong, Kwantung	1,008,814	673,375
Japan	2,464,732	3,642,186
Other countries	54,476	241,464
Other lead manufactures	698,726	1,323,615
Zinc		
Ores and concentrates, tons	2,269	1,486
Dross	695,819	468,451
Cast in slabs, blocks, and pigs	8,377,657	5,116,145
Exported to		
Belgium	168,042	61,050
France	1,120,026	392,091
Germany	62,040	1,512,056
Italy	112,089	560,183
Netherlands	.....	217,992
United Kingdom	3,574,412	588,457
Other Europe	112,258	11,303
Argentina	952,364	287
Japan	2,054,344	1,623,685
Other countries	222,082	149,041
Sheets, strips other forms	782,768	664,916
Dust	186,443	309,759
Other zinc manufactures	211,623	668,602

The Market Report

Copper, Silver, and Zinc in Good Demand at Firm Prices

New York, May 2, 1928—The general tone of the non-ferrous metal markets is firm, and a feeling of optimism prevails. Copper has had a better than normal week as to volume of sales, with quotations well maintained. Zinc has advanced slightly and sold in larger volume than it did in the last half of April. Silver shows a net gain of ¾c. from a week ago, owing to active buying in China and India. On the other hand, lead and tin are dull.

Copper Continues at 14¼c.

The copper market is virtually unchanged from last week, both in price and in volume of sales, though in the last two or three days there has been less tendency to offer the metal at concessions from the prices at which most of the producers have held for some weeks—namely, 14¼c., Connecticut, and 14⅜c. at so-called Middle Western points. A little copper was sold yesterday and today at 14.225c., Valley, but the 14¼c. level seems to be fairly well maintained. Brass mills have bought a good tonnage and some interest has been shown by sheet and tube manufacturers; but the wire business has not been so good. Manufacturers are active, but report advance orders a little disappointing. June shipment has been in most demand, May copper being practically all bought. Owing to delay in specifications, however, refineries find themselves with comparatively more cathodes on hand than shapes, so there has been some difficulty in prompt shipment. It seems likely that refined stocks will show a material decrease when the April statistics are issued. The export price continues at 14¼c., c.i.f., with satisfactory sales. The April total of sales was close to 54,000 long tons.

Daily Prices of Metals

April / May	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
26	13.95@14.025	51.875	6.10	5.975@6.00	5.80
27	14.00@14.025	52.00	6.10	6.00	5.80
28	14.00@14.025	52.00	6.10	6.00	5.80@5.825
30	14.025	50.875	6.10	6.00	5.80@5.825
1	14.025	51.00	6.05@6.10	6.00	5.85
2	14.00@14.025	51.50	6.10	6.00	5.875
	14.013	51.542	6.096	5.998	5.825

Average prices for calendar week ending April 28, 1928, are: Copper, 14.002; Straits tin, 52.042; N. Y. lead, 6.100; St. Louis lead, 5.996; zinc, 5.802; and silver, 57.792.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

April / May	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
26	61 9/16	61¾	66¼	232¼	232½	20⅜	20 9/16	26 1/16	25 11/16
27	61 9/16	61¾	66½	232¾	233¼	20⅜	20⅜	26 3/16	25⅞
30	61⅝	61⅞	66½	230¾	231½	20¼	20 9/16	26 1/16	25 11/16
1	61 9/16	61 13/16	66½	229¾	230⅛	20 5/16	20 9/16	25 13/16	25 9/16
2	61 9/16	61 13/16	66½	231¾	231¼	20 7/16	20⅝	26⅛	25⅞

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

April	Sterling Exchange "Checks"	Silver		Gold London	April / May	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
26	4.87½	57⅜	26½	84s11d	30	4.87 9/16	58½	26 1/16	84s11d
27	4.87⅝	58	26 11/16	84s11d	1	4.87½	58½	26 13/16	84s10½d
28	4.87⅝	58⅛	26 11/16	.....	2	4.87½	58⅜	26¾	84s11d
					Avg.		58.188		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Average Metal Prices for April, 1928

COPPER:	
New York Electrolytic	13.986
London Standard Spot	61.678
London Electrolytic Spot	66.500
LEAD:	
New York	6.100
St. Louis	5.991
London Spot	20.306
London Forward	20.563
SILVER:	
New York	57.395
London	26.409
Sterling Exchange	487.785
ZINC:	
St. Louis	5.759
London Spot	25.493
London Forward	25.316
TIN:	
Straits	52.270
London	234.204
QUICKSILVER	123.740
ANTIMONY	9.865
PLATINUM:	
Refined	80.000
Crude	70.000
ALUMINUM, 98 PER CENT.	24.300

Quiet Week in Lead

Sales of lead have been considerably below normal during the week ending today. No appreciable change is observed in the market, although two sales, of fair tonnage, were reported that might be considered as below the prevailing levels of 6.10c., New York, and 6.00c., St. Louis. Several of the largest domestic producers oversold their supply of metal in April, and it is unlikely that a tendency to force the metal on the market will be manifested because of a temporary lapse in volume of business. London is stronger, a small advance again today tending to strengthen the position abroad.

Zinc Firmly Held

Galvanizers have taken somewhat more interest in the zinc market this

last week, though the total of sales does not bulk particularly large. Smelters are not anxious sellers in the current market, the differential between ore and metal prices not being satisfactory to them. A few days ago, spot zinc could readily be obtained for 5.80c., but the price today is 5 to 7½ points above this level, with 5.90c. or better asked for forward shipment. A little Brass Special has been sold at about 7½ points premium over Prime Western.

Tin Inactive

The recent activity of the tin market has subsided, and the condition of the market for the current week may justly be described as exceptionally quiet. The price of tin has been fairly well maintained in spite of the small volume of business taking place. Forward tin is about ¼c. under prompt.

China and India Make Heavy Silver Purchases

The silver market during the past week was featured by heavy buying orders from both China and India. As a result prices rose sharply to new highs for the year, both in New York and London. The rates are slightly lower today because of lessened demand from the Far East. The market closes steady with sellers not pressing.

Mexican Dollars (old Mexican pesos): April 26th, 44⅛c.; 27th, 44½c.; 28th, 44⅝c.; 30th and May 1st, 44⅞c.; 2d, 44¾c.

Foreign Exchanges Dull

Foreign exchanges are dull. Closing cable quotations on Tuesday, May 1, were as follows: Francs, 3.93 7/16c.; lire, 5.27¼c.; and marks, 23.92c. Canadian dollars, ⅛ of 1 per cent discount.

Ore Prices Unchanged in Joplin

Joplin, Mo., April 28, 1928

Blende

	Per Ton
High	$40.10
Premium blende, basis 60 per cent zinc	$39.00@ 40.00
Prime Western, basis 60 per cent zinc	38.00
Fines and slimes, 60 per cent zinc	$34.00@ 37.00
Average settling price, all zinc	37.33

Galena

High	$78.40
Basis 80 per cent lead	77.50
Average settling price, all lead	76.39

Shipments for the week: Blende, 14,676; lead, 1,162. Value, all ores the week, $636,060.

Shipments four months: Blende, 183,257; lead, 27,076. Value, all ores four months, $9,031,650.

Buyers were actively seeking a still larger tonnage this afternoon; a total of 8,580 tons was reported bought. Stocks have been lowered approximately 20,000 tons during April, and buyers would further reduce them if they could make contracts on the current basis price, as they need the ore.

Platteville, Wis., April 28, 1928

Zinc Blende	Per Ton
Blende, basis 60 per cent	$40.75
Lead Ore	
Lead, basis 80 per cent lead	$77.00

Shipments for the week: Blende, 643 tons; lead, 40 tons. Shipments for the year: Blende, 12,448 tons; lead, 720 tons. Shipments for the week to separating plants, 1,121 tons blende.

Steel Production Has Record Four Months

Pittsburgh, May 1, 1928

Steel production in the first three months of the year was fully equal to the heaviest production in that period of any previous year. April substantially sustained the March rate, when usually there has been a decrease of 5 per cent or more, resulting in production for the four months making a new high record by about 2 per cent. In the last week of April the usual seasonal decrease set in, being merely belated, and prospects are for substantial decreases to July 1, whereby the half year may possibly fail to make a new record.

In bars, shapes, plates, and wire products prices were higher on second-quarter contracts, leading to particularly heavy specifying on first-quarter contracts, shipments against these specifications continuing in April.

Bars, shapes, and plates are steady at 1.85c. which is the second-quarter price, against 1.80c. for first quarter, and mills state they will demand 1.90c. for third quarter. Sheets have been softening farther, selling as low as 2.70c. for black, 3.60c. for galvanized, and 2.00c. for blue annealed, matching low prices of April and December last year, and otherwise the lowest prices for more than ten years. Some sales are still being made at higher prices, according to circumstances. The 5 per cent advance in standard pipe of early April is holding.

Automobile production has been substantially the same as a year ago and is now on the verge of decreasing. In fabricated structural steel and in farm implements requirements have run heavier. Railroad and miscellaneous demand has been lighter, and thus far there has not been the heavy demand for line pipe, chiefly for gas lines, of last year, though some important gas lines are under project.

Steel Corporation earnings were 31 per cent higher in the March than in the December quarter, and independents showed somewhat similar gains, increases being due almost wholly to a 30 per cent increase in steel production and shipments. In recent years the first quarter has regularly shown the largest tonnage.

Pig Iron—Pig iron was quiet in all districts in April, with prices generally unchanged. The Valley market remains at $17.50 for bessemer, $17 for basic, and $17.25 for foundry, the basic quotation being practically nominal, and confined to local territory.

Connellsville Coke—The market has been extremely dull. Spot: Heating, $2.25@$2.50; furnace, $2.60@$2.75; foundry, $3.75@$4.25, per net ton at ovens.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.50c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £105 per long ton for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, 9½c., for all positions. Market quiet. Cookson's "C" grade, spot, 16⅜c.

Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c. Nominal.

BISMUTH—Per lb., in ton lots, $2.10. Smaller lots $2.25 and up. London 9s.

CADMIUM—Per lb., 60c. London, 2s. @2s. 1d. for Australian metal.

COBALT—Per lb., f.o.b. Canadian works: Shot, 96@98 per cent, $2.50. Black oxide, 70 per cent, $2.10. London, 10s. for metal; 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM OXIDE—Per gram in 300- to 500-gram lots, $5.

IRIDIUM—Per oz., $275@$300 for 98 @99 per cent sponge and powder. Market inactive.

[1]LITHIUM—Per oz., 98@99 per cent grade in 1- to 5-lb. lots, $5.

MAGNESIUM—Per lb., in ton lots: 8-lb. ingots (3x3x16 in.), 98c.; 3-lb. sticks (1⅜x33 in.), $0.95@$1; 10-oz. sticks (1x12 in.), 85@90c. Market active. London 4s. for 99 per cent ingots or sticks.

[1]MOLYBDENUM—Per gram, 99 per cent, 4c. (Usually sold as calcium molybdate or ferromolybdenum, which see).

MONEL METAL—Per lb. base price for shot, 28c., f.o.b. Huntington, W. Va.

NICKEL—Per lb., ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.90 per cent grade), for single lots of spot metal. Good demand. London, per long ton, £170@£175 according to quantity. Market fairly active.

OSMIUM—Per oz., $65@$80; London, £15@£18.

PALLADIUM — Per oz., $46@$49. Small lots bring up to $54. London £10¼@£11½. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $80 until May 1, when the price was reduced to $78. Dealers and refiners quoted the trade for refined metal, per oz., cash, for wholesale lots, $74 bid, $76 @$77 asked. Market quiet.

London, per oz., £17@£17 2s. 9d. for refined; crude and scrap, nominal at £15 10s.@£16.

QUICKSILVER — Per 76-lb. flask, $123@$124. Market steady. San Francisco wires $124.33. London firm at £22¼@£22½.

[1]Price furnished by Foote Mineral Co., Philadelphia.

RADIUM — Per mg. radium content, $70.

RHODIUM—Per oz., $55@$60. Nominal.

RUTHENIUM — Per oz., $45@$60. Nominal.

[1]SELENIUM — Per lb. in ton lots: Black, powdered, amorphous, 99.5 per cent pure, $2.25. London, 7s. 8d.@ 7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 20c.; tantalum powder, 12c. Nominal.

TELLURIUM—Per oz., 15@18c.

[1]THALLIUM METAL—Per oz.: Ingot, 99 per cent pure, $1.06 in 25-lb. lots.

TUNGSTEN POWDER — Per lb. contained tungsten, 97 to 98 per cent pure, $0.94@$0.96.

[1]ZIRCONIUM METAL—Per oz., 98 per cent grade, $1.56 in 5- to 10-lb. lots.

Metallic Ores

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $22@$23.50 for 45 to 50 per cent Cr_2O_3 ore. Prices firm.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores.

Mesabi, non-bessemer, 51½ per cent iron, $4.25. Old Range, $4.40.

Mesabi, bessemer, 51½ per cent iron, $4.40. Old Range, bessemer, 51½ per cent, $4.55.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 58 to 63 per cent, 8@8½c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

North African, low-phosphorus, 11 @11½c., nominal.

Spanish foundry or basic, 50@54 per cent, 8½@9c. Nominal.

Swedish foundry or basic, 66@68 per cent, 9@9½c.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, Brazilian and Indian ores, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c.

Per ton in carload lots:

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian and Cuban, $70@$80. Caucasian, minimum 85 per cent, $70. Montana, 70 to 75 per cent, $70@$80. Domestic, 70 to 72 per cent, $40@$50.

TANTALUM ORE—Per unit of combined Ta_2O_5 and Cb_2O_5, basis 65 per cent ore, $30.

TITANIUM ORE—Ilmenite, per gross ton, 52 to 60 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., 93 per cent concentrate, 10c. for 30 ton lots.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $10.50@$10.60, Western scheelite, $10.50@$10.75. Market showing signs of activity.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $8 in 30 ton lots.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]AMBLYGONITE—Per ton, f.o.b. mines: 8@9 per cent lithium oxide, $50@$60.

ASBESTOS—Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading interest:

Crude No. 1, $600@$650; crude No. 2, $375@$400; spinning fibers, $190@ $225; magnesia and compressed sheet fibers, $160@$175; shingle stock, $55@ $115, various grades; paper stock, $45@ $50; cement stock, $25; short fibers, $10@$20; floats, $15. Market firm, demand fair.

Per ton c.i.f. New York: Rhodesian crude No. 1, $450; No. 2, $350.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude (per long ton), $7. Washed and water floated to 97 per cent through 300 mesh, $19. Demand slackening; production about 70 per cent of normal.

Missouri: Water ground and floated, bleached, $23; $25 in less than car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $6.50@$7.50, f.o.b. mines. Market fair.

BAUXITE—Per long ton: Domestic ore, crushed and dried, 55 to 58 per cent Al_2O_3, less than 5 per cent SiO_2, 1.5 to 2.5 per cent Fe_2O_3, $7.50@$8.50, f.o.b. *Georgia* mines. Pulverized and dried, $14; calcined, 78 to 84 per cent Al_2O_3, $18@$20.

Per metric ton, foreign, c.i.f. Atlantic port: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.80@ $6.50; Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 5 per cent SiO_2, $6@$8.

BORAX—Per lb.: Carload lots, in bags, crystals, 4c.; granulated or powdered, 3¾c.; f.o.b. plant, Pennsylvania. Market fair.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York*, $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $10@$15; ground, $7@$10.

Florida, pressed pottery, bulk, $13.50; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour, No. 1, $20; No. 2, $17. Market slow.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports: Lump, $13@$21; powdered, $45@$50.

DIATOMITE — Per short ton, f.o.b. plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25; natural aggregate, ¼ in., $18@$20; air-floated powder, $45. Over 85 per cent silica, 98 per cent through 200 mesh, $25@$26, depending on quantity. Market improving.

EMERY — F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 5½c.; domestic, 3½c. Market good.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $5.50@$7.50. Demand fair.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $9. Market fair.

New York, Per ton: f.o.b. cars, No. 1 crude, $9. Market quiet.

Tennessee, per ton: No. 1, pottery. 140 mesh, $16; 200 mesh, $18. No. 2 enamel, 140 mesh, $13.75; 200 mesh, $15.50; demand fair.

Maine, per ton: Best pottery grade, ground, $19. Market fair.

FLUORSPAR—Per ton: F.o.b. *Kentucky* and *Illinois* mines.

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $15.50@$16. Foundry lump, 85-5, $18. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $30 in car lots. Market quiet.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16.50; 94-3 lump, $21.50; 97-2 sacked, $35. Market fair.

Foreign spar, duty paid, $15.50@$16, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 60 to 100 mesh, $14; 100 mesh up, $8; 200 mesh up, $14. Market fair at unchanged prices.

Powdered, import duty paid, $24@ $25 per ton.

GARNET — Per ton; domestic, f.o.b. mines, $85. Market easy.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb.: F.o.b. *New York*.

Ceylon lump, 8@8½c.; chip, 7@7½c.; dust, 3@5½c.; Madagascar flake, 7@8c. Market quiet, some price-cutting in order to secure business.

No. 1 flake, 10c. and up. No. 2 flake, 7c. and up. Foundry facings, 3c. and up. Amorphous and crystalline, fine ground, 3c. and up. Market fair.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade in carload lots, $25. Market continues quiet.

[1]Price furnished by Foote Mineral Co., Philadelphia.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $2.75@$3; ground, $4@$9; agricultural, $6@$10; calcined, $7@$13.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c. Good demand.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 75c.@$2.

Agricultural, $1 up to $4 or $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $42; Grade B, $37.50; dead burned, $28, crude, $11. F.o.b. Eastern seaboard, calcined, $40. Market slow. Magnesite of Indian origin is reported in the domestic market.

MICA—Per ton, f. o.b. plant:

New Hampshire: Mine run, $320; clean shop scrap, $25; mine scrap, $22.40. White dry ground, 20 mesh, $25; 40 mesh, $40; 60 mesh, $65; 100 mesh, $75; 200 mesh, $85. Market shows some signs of improvement.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, dark, free from iron, per lb., f.o.b. *New York*, duty paid: No. A1, $3.50@$4; No. 1, $3; No. 2, $2.50; No. 3, $1.30; No. 4, 70@80c.; No. 5, 45c. Market fair.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $130.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade. 99 per cent through 225 mesh, $18. Market good.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7; 75 per cent, $6.25; 74@75 per cent, $6; 70 per cent, $4.50; 68 per cent, $4.10; 66 per cent, $4. Prices firm.

Florida, pebble, domestic: 76@77 per cent, $6; 74@75 per cent, $5; 72 per cent, $4; 70 per cent, $3.50. Market fair.

Tennessee, ground, 97 per cent through 200 mesh, 33 per cent P_2O_5, $9.50 per ton. Brown lump for acid manufacture, per gross ton, $5.75 on 75 per cent basis; $5 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton). Market strong after period of considerable activity.

POTASH—The ruling contract prices are as follows:

	Bags	Bulk
Muriate of potash 80 @ 85 per cent, basis 80 per cent....	36.40	34.80
Sulphate of potash 90 @ 95 per cent, basis 90 per cent....	47.30	45.70
Sulphate of potash-magnesia 48 @ 53 per cent, basis 48 per cent	27.25	25.65
Manure salt 30 per cent.....	21.75	18.75
Manure salt 20 per cent.....	15.40	12.40
Kainit 14 @ 16 per cent.....	12.50	9.50
Kainit 12.4 per cent.....	12.00	9.00

Two thousand pounds net weight, c.i.f. Atlantic and Gulf ports. German weights, tares and analyses.

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur, furnace size, 2½-in. diameter, Spanish, 13c.; Tharsis, 14c. Cinder from ore to remain property of buyers. Inquiries reported as improving.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 40c. For optical purposes, double above prices; larger crystals still higher.

SILICA—Per ton: Water ground and floated, in bags, f.o.b. Illinois: 400 mesh, $31; 350 mesh, $26; 250 mesh, $18. Market improving. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35 @$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content. Nominal.

SULPHUR—Per ton for domestic market, $18, f.o.b. Texas mines; $22 for export, Atlantic ports. Prices in reality are on a c.i.f. basis, but the average price reduced to an f.a.s. figure is about as given. Open prices $1 higher than above.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $9.50@$10; 96½ to 98 per cent through 200 mesh, medium white, $8.50@$9; packed in 50-lb. paper bags; prices $1 per ton less in burlap sacks. Market weak. Growing tendency to replace talc with cheaper substitutes reported.

New York: Double air-floated, 200 mesh, $13.75; 325 mesh, $14.75. Demand fair.

Georgia: Powdered, gray, $7.50@ $10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9. Market fair.

New Jersey: Soapstone, ground, $10 @$12; market fair.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh; rose and cream colored, $14. Double ground through 110 mesh; rose and cream, $17. Air-floated through 200 mesh, rose and cream, $25; mill run, $15. Demand fair.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c. Small lots slightly higher. Delivered near by. Quiet. London, per long ton, £17¾@£18 quoted for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE — Per lb. of contained Mo, 95c., delivered.

COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 5.10@5.25c., for either large or small crystals.

[1]Price furnished by Foote Mineral Co., Philadelphia.

SODIUM NITRATE—Per 100 lb.; crude, in bags ex vessel, Atlantic ports, $2.32½ for spot; future delivery, $2.17½@$2.25.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $17@$20.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6⅝c.; French red seal, in bags, 9⅜c.

Ferro-Alloys

[1]FERROCERIUM—Per lb., $9 in 15-75 lb. lots.

FERROCHROME—Per lb. of contained chromium, 60@70 per cent chromium, 4 to 6 per cent carbon, 11c. Spot shipments slightly higher. Freight allowed in carload lots east of Mississippi River.

FERROMANGANESE — Per gross ton furnace: Domestic and foreign, 78@82 per cent, $100 for second quarter of 1928. Spiegeleisen, 19@21 per cent, $31@$32 on carload business, f.o.b. furnace.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.20.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River: 50 per cent, $83.50; 75 per cent, $130; 14@17 per cent, $45. Market fairly active.

FERROTITANIUM—Per ton: For 15 to 18 per cent material, $200, f.o.b. Niagara Falls, N. Y.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, 92@95c., f.o.b. works.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, $3.15@$3.65, depending on grade and quantity. Market active.

Metal Products

ROLLED COPPER—Sheets, 23c.; wire, 16c. per lb., f.o.b. mill.

LEAD SHEETS—Full rolled, 9¼c. per lb.; clipped, 10c.

NICKEL SILVER—29½c. per lb. for 18 per cent nickel Grade A sheets.

YELLOW (MUNTZ) METAL—Dimension sheets, 19¾c. per lb.; rods, 16¾c. per lb.

ZINC SHEETS — 9c. per lb., f.o.b. works.

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35 @$38.

MAGNESITE BRICK—Per net ton, f.o.b. works: 9-in. straights, $65.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio*, $43; *Alabama*, $51; *Illinois*, $52.

[1]ZIRKITE—Per lb.: Powdered, 80 per cent ZrO_2, 3½c. Brick, straights, 80c.@ $1 each.

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1927	1928	1927	1928	1927	1928
January	55.795	57.135	25.863	26.313	484.775	487.098
February	57.898	57.016	26.854	26 205	484.551	487 008
March	55.506	57 245	25.655	26.329	484.887	487.558
April	56.399	57.395	26.136	26.409	485.178	487.785
May	56.280	.....	26.072	.....	485.288	.....
June	56.769	.....	26.203	.....	485.183	.....
July	56.360	.....	25.983	.....	485.145	.....
August	54.718	.....	25.224	.....	485.546	.....
September	55.445	.....	25.565	.....	485.878	.....
October	56.035	.....	25.776	.....	486.533	.....
November	57.474	.....	26.526	.....	486.956	.....
December	57.957	.....	26.701	.....	487.714	.....
Year	56.370	.....	26.047	.....	485.636	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London Spot			
	Electrolytic		Standard		Electrolytic	
	1927	1928	1927	1928	1927	1928
January	12 990	13.854	55.414	61.912	62.375	66.575
February	12 682	13.823	54.438	61.670	61.119	66.381
March	13.079	13.845	55.935	61.148	62.641	66.443
April	12.808	13.986	55.056	61.678	61.526	66.500
May	12.621	.....	54.563	.....	60.881	.....
June	12.370	.....	54.030	.....	59.881	.....
July	12.532	.....	54.551	.....	60.089	.....
August	12.971	.....	55.364	.....	62.227	.....
September	12.940	.....	54.455	.....	61.830	.....
October	12.958	.....	55.119	.....	62.256	.....
November	13.319	.....	58.830	.....	63.761	.....
December	13.774	.....	60.078	.....	66.181	.....
Year	12.920	.....	55.653	.....	62.064	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1927	1928	1927	1928	1927 Spot	1927 3 Mos.	1928 Spot	1928 3 Mos
January	7.577	6.500	7.392	6.280	27.485	27.786	21.773	22.213
February	7.420	6.329	7.286	6.069	27.344	27.781	20.283	20.747
March	7.577	6.000	7.328	5.805	27.845	28.302	19.938	20.352
April	7.126	6.100	6.807	5.991	26.546	27.053	20.306	20.563
May	6.616	.....	6.269	.....	25.054	25.526	.....	.....
June	6.414	.....	6.150	.....	24.438	24.750	.....	.....
July	6.344	.....	6.120	.....	23.491	23.932	.....	.....
August	6.681	.....	6.367	.....	23.119	23.540	.....	.....
September	6.297	.....	6.044	.....	21.446	21.994	.....	.....
October	6.250	.....	6.013	.....	20.479	20.946	.....	.....
November	6.259	.....	6.035	.....	20.889	21.318	.....	.....
December	6.504	.....	6.319	.....	22.163	22.441	.....	.....
Year	6.755	.....	6.511	.....	24.192	24.614	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York				London	
	1927	1928	1927	1928	1927	1928
	99%		Straits		Spot	
January	64.785	55.180	66.415	55.650	297.804	253.222
February	66.528	51.793	69.142	52.440	306.125	233.833
March	67.833	51.630	69.199	52.220	313.315	232.722
April	66.069	.....	67.933	52.270	302.572	234.204
May	63.935	.....	67.510	.....	294.938	.....
June	64.226	.....	67.466	.....	296.006	.....
July	62.625	.....	64.110	.....	288.690	.....
August	63.523	.....	64.431	.....	293.193	.....
September	60.735	.....	61.490	.....	280.432	.....
October	57.560	.....	58.450	.....	264.631	.....
November	57.089	.....	57.641	.....	262.591	.....
December	58.053	.....	58.452	.....	267.138	.....
Year	62.747	.....	64.353	.....	288.953	.....

New York quotations, cents per pound. Quotations on 99 per cent tin discontinued on April 1, because of absence of business. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1927	1928	1927 Spot	1927 3 Mos.	1928 Spot	1928 3 Mos.
January	6.661	5.643	30.979	30.938	26.125	26.051
February	6.673	5.551	29.931	30.109	25.518	25.506
March	6.692	5 624	30.649	30.889	25.082	24.960
April	6.338	5.759	29.579	29.901	25.493	25 316
May	6.075	.....	29.034	29.131	.....	.....
June	6.213	.....	28.598	28.613	.....	.....
July	6.229	.....	28.280	28.021	.....	.....
August	6.342	.....	28.210	28.068	.....	.....
September	6.212	.....	27.347	27.327	.....	.....
October	5.996	.....	26.899	26.634	.....	.....
November	5.745	.....	26.281	26.006	.....	.....
December	5.722	.....	26.363	26.109	.....	.....
Year	6.242	.....	28.513	28.479	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton

Antimony, Quicksilver and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)			
	New York		New York		Refined		Crude	
	1927	1928	1927	1928	1927	1928	1927	1928
Jan	13.910	10.863	101.200	123.620	109.520	79.280	99.820	69.280
Feb	14.509	10.842	101.727	121.370	107.545	84.783	99.295	74.783
March	12.801	10.083	110.259	122.557	108.000	83.000	100.426	70.000
April	14.166	9.865	123.250	123.740	101.885	80.000	91.865	70.000
May	12.975	.....	123.900	.....	84.680	.....	75.000	.....
June	12.447	.....	118.096	.....	72.000	.....	62.500	.....
July	11.880	.....	119.880	.....	72.000	.....	61.520	.....
Aug	11.826	.....	119.111	.....	72.000	.....	62.000	.....
Sept	11.073	.....	119.640	.....	72.000	.....	62.000	.....
Oct	11.165	.....	126.200	.....	72.000	.....	62.000	.....
Nov	10.763	.....	127.706	.....	72.000	.....	62.000	.....
Dec	11.195	.....	126.933	.....	72.000	.....	62.000	.....
Year	12.393	.....	118.159	.....	84.636	.....	75.036	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. Prior to June, 1927, the unit had been the 75-lb. flask. (c) Platinum in dollars per ounce.

Pig Iron, Pittsburgh, and Aluminum 98 Per Cent

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1927	1928	1927	1928	1927	1928	1927	1928
Jan	19.50	17.50	18.16	17.00	18.50	17.25	26.270	24.300
Feb	19.02	17.50	18.00	17.00	18.50	17.25	26.000	24.300
March	19.37	17.50	18.28	17.00	18.50	17.25	26.000	24.300
April	19.50	17.50	19.00	17.00	18.50	17.25	26.000	24.300
May	19.24	.....	18.24	.....	18.50	.....	26.000	.....
June	18.96	.....	17.96	.....	18.35	.....	26.000	.....
July	18.50	.....	17.50	.....	18.00	.....	26.000	.....
Aug	18.50	.....	17.32	.....	17.65	.....	26.000	.....
Sept	18.00	.....	17.11	.....	17.50	.....	26.000	.....
Oct	18.00	.....	17.00	.....	17.50	.....	25.600	.....
Nov	18.00	.....	17.00	.....	17.47	.....	25.000	.....
Dec	17.69	.....	17.00	.....	17.25	.....	24.785	.....
Year	18.69	.....	17.71	.....	18.02	.....	25.808	.....

Iron in dollars per long ton. Aluminum in cents per pound, 98 per cent grade.

New figures, pig iron f.o.b. Mahoning and Shenango valley furnaces, instead of delivered Pittsburgh. Difference from former figures, which were delivered Pittsburgh, $1.76, this being the freight.

Monthly Crude Copper Output in Short Tons

Domestic

	1927				1928	
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Alaska shipments	4,747	1,402	1,655	2,084	908	3,495
Butte & Superior	.....	.....	†238	.....	.....	.....
Calumet & Arizona	2,157	2,018	2,065	2,066	2,041	2,019
Magma	1,298	1,404	652	1,300	1,398	1,346
Miami	2,245	2,099	2,032	1,963	1,955	2,029
New Cornelia	3,718	3,613	3,607	3,672	3,267	3,318
Nevada Con	.....	.....	†26,253	.....	.....	.....
Old Dominion	871	832	801	*996	*992	1,009
Phelps Dodge††	7,770	7,799	7,757	8,273	7,331	7,803
United Verde Extension	1,933	1,698	1,930	1,633	1,624	1,699
Utah Copper	.....	.....	†27,810	.....	.....	.....
Tennessee Copper	532	594	617	510	514	596

Foreign

Braden	9,343	9,354	9,348	.....	.....	.....
Boleo, Mexico	990	990	1,001	1,068	1,262	1,130
Bwana M'Kubwa	496	447	554	677	600	.....
Chile	8,954	8,960	8,972	.....	.....	.....
Furukawa, Japan	1,501	1,649	1,563	1,548	1,563	.....
Granby Cons., Canada	2,550	2,208	1,936	2,305	2,155	2.326
Mount Lyell, Aust	.....	.....	†2,064	.....	.....	.....
Sumitomo, Japan	1,608	1,317	1,412	1,317	1,381	.....
Union Miniere, Africa	10,230	10,890	10,803	10,390	9,590	.....

†Three months. *Includes Arizona Commercial
††Moctezuma is included.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1926		1927		1928	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	71,026	2,291	76,198	2,458	68,469	2,209
February	68,131	2,433	69,202	2,472	67,423	2,325
March	75,728	2,443	69,314	2,236	70,172	2,264
April	73,454	2,448	71,122	2,371	.....	.....
May	73,542	2,372	71,613	2,310	.....	.....
June	71,317	2,377	69,539	2,318	.....	.....
July	72,228	2,330	65,545	2,114	.....	.....
August	72,014	2,323	67,248	2,169	.....	.....
September	72,672	2,421	65,936	2,198	.....	.....
October	75,099	2,423	68,595	2,225	.....	.....
November	74,947	2,498	68,080	2,269	.....	.....
December	72,205	2,329	67,377	2,173	.....	.....
Total	872,509	.....	829,878	.....	206,064	.....
Monthly average	72,709	.....	69,165	.....	68,688	.....
Average of daily rate	.....	2,390	.....	2,274	.....	2,264

Mining Stocks—Week Ended April 28, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	72¼	66¼	72¾	Ap.14, My.21 Q	0.75
Ariz. Com'l	Boston	4¼	3½	3⅝	Ja. 19, Ja. 31 SA	0.25
Cal. & Ariz	New York	102⅜	96	99⅝	Ma. 3, Ma. 19 Q	1.50
Calumet & Hecla	Boston	22	20⅜	21⅛	Fe. 28, Ma. 15 Q	0.50
Cerro de Pasco	New York	70½	66	68¼	Ap.12, My.1 Q	1.00
Chile Copper	New York	43⅛	40⅛	43¼	Jn.6, Jn.30 Q	0.62½
Con. Coppermines	N. Y. Curb	11⅛	10¼	11		
Copper Range	Boston	17⅛	15⅛	17⅛	Ma. 24, Ap. 20 A	1.00
Crystal Copper	Boston Curb	95	78	93		
East Butte	Boston	1⅜	1⅛	1⅜	Dec., 1919	0.50
Granby Consol	New York	48½	45⅜	48½	Ap.13, My.1 Q	1.00
Greene Cananea	New York	122½	115½	119	Nov., 1920	0.50
Howe Sound	New York	53⅞	50	53⅜	Ma.31, Ap.16, Q	1.00
Inspiration Consol	New York	22⅞	21	22⅛	Apr. 1927 Q	0.25
Isle Royale	Boston	15	13⅜	14⅜	Fe.28, Ma.15 SA	0.50
Kennecott	New York	86½	83⅜	86	Ma. 2, Ap. 2 Q	1.25
Magma Copper	New York	49	47⅜	48⅜	Ma.31, Ap.16 Q	0.75
Mason Valley	N. Y. Curb	1⅞	1⅛	1⅛		
Miami Copper	New York	19⅜	19	19⅛	My.1, My.15, Q	0.37½
Mohawk	Boston	59½	58	59⅜	Ap. 30, Jn. 1 Q	1.00
Montana-Idaho	Spokane	*37	*34½	*34½		
Mother Lode Coal	New York	3½	3½	3½	De.16, De.31 SA	0.25
Nevada Consol	New York	21	20	21	Ma.16, Ma.31 Q	0.375
New Cornelia	Boston	28½	28	28½	My. 4, My. 21 Q	0.50
Noranda	N. Y. Curb	18⅜	17½	18⅛		
North Butte	Boston	2 1/16	2	2 1/16	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*87	*80	*83	Sept., 1926	0.03
Old Dominion	Boston	10½	9½	10½	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	127	125	125	Ma.20, Ap.2 Q	1.50
Quincy	Boston	19⅜	12½	19½	March, 1920	1.00
St. Mary's Min. Ld	Boston	27	24½	27	Ap.1928 A	2.00
Seneca Copper	New York	2⅜	2¼	2⅜		
Shattuck-Denn	N. Y. Curb	23⅜	17½	23		
Tenn. C. & C	New York	13⅜	12⅜	12⅜	Fe.29, Ma.15,Q	0.12½
United Verde Ex	N. Y. Curb	17½	17½	17⅝	Ap.6, My.1, Q	0.50
Utah Copper	New York			150	Ma.16, Ma.31 Q	1.50
Utah Metal & T	Boston	1⅜	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	*85	*80	*81		
NICKEL-COPPER						
Internat. Nickel	New York	92	83¾	90⅛	Ma.15, Ma.31Q	0.50
Internat. Nickel pfd	New York			115	Ap.12, My.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*8½	*7½	*7½	June, 1927	0.005
National Lead	New York	133½	126	123	Ma.16, Ma.31Q	1.25
National Lead, pfd. A	New York	147	147	147	Ju.1, Ju.15 Q	1.75
National Lead, pfd. B	New York	120	120	120	Ap. 23, My. 1 Q	1.50
St. Joseph Lead	New York	39⅞	38½	39½	Jn.9, Jn.20, QX	0.75
ZINC						
Am. Z. L. & S	New York	26⅞	24½	25½	May, 1917	1.00
Am. Z. L. & S. pfd	New York	91	86	88½	Nov., 1920	1.50
Butte C. & Z	New York	6⅜	6	6	De., 1926	0.50
Butte & Superior	New York	10½	10⅛	10⅛	Ma.14, Ma.31 Q	0.50
Callahan Zn-Ld	New York	4⅜	2⅞	4⅜	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	12	11¼	11⅛	Ap., 1927	0.25
Eagle-Picher	Cincinnati	17½	16¼	16⅜	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati			103	Ma. 31, Ap. 16 Q	1.50
New Jersey Zn	N. Y. Curb	251	205	249	Ap. 20, My. 10 Q	2.00
Treadwell-Yukon	Toronto	22.25	20.75	20.75		
United Zinc	N. Y. Curb	1.00	*25	1.00		
Yellow Pine	Los Angeles	*32	*31	*32	Dec., 1925 Q	0.04
GOLD						
Alaska Juneau	New York	4⅛	3½	4⅛		
Argonaut	Toronto	*7½	*6	*7½		
Barry-Hollinger	Toronto	1.27	1.02	1.03		
Central Manitoba	Toronto	1.33	1.26	1.27		
Con.W.Dome L. new	Toronto	*11½	*9	*11		
Cresson Consol. G	N. Y. Curb	1⅜	1 1/16	1 1/16	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	9⅞	8½	9⅛	Ma.31, Ap.20 Q	0.25
Golden Cycle	Colo.Springs	†1.78	†1.75		Fe.29, Ma.10 Q	0.04
Gold Hill	Toronto	*22½	*17½	*18		
Hollinger Consol	Toronto	16.05	15.90	16.00	My.2, My.19	0.10
Homestake Mining	New York	74	74	74	Ap.20, Ap.25 M	0.50
Kirkland Lake	Toronto	1.90	1.81	1.82		
Lake Shore	Toronto	23.50	23.25	23.25	Ma.1, Ma.15QX	0.20
McIntyre-Porcupine	New York	26	26	26	May1, Ju.1 Q	0.25
Portland	Colo.Springs	†20	†17½		Ap., 1927	0.02
Rand Mines	New York			40⅜	Fe.21-28 Am.Sh.	1.52
Sylvanite	Toronto	3.25	3.15	3.25		
Teck-Hughes	Toronto	9.50	9.15	9.30	Ja. 17, Fe. 1 X	0.15
Tom Reed	Los Angeles	*32½	*30	*32	Dec., 1926	0.02
Tough-Oakes	Toronto	*52	*39	*39		
Vipond Cons	Toronto	*65	*58	*60	April, 1927	0.03
Wright-Hargreaves	Toronto	4.60	4.50	4.55	Ap.13, My.1 Q	0.05
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	26⅜	24⅛	26⅜		
Con. Cortez	N. Y. Curb	*30	*28	*30		
Dolores Esperanza	N. Y. Curb	2.00	*60	1 1/16	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	16⅞	16⅞	16⅞	Ap.18, Ap.28 Q	0.50
Premier Gold	N. Y. Curb	2⅛	2⅛	2⅛	Ma.15, Ap.4	0.08
Tonopah Belmont	N. Y. Curb	2 1/16	2 1/16	2 1/16	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*10	*10	*10	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	4 1/16	4	4	Mar.31, Ap.21 SA	0.07½
West End Consol	N. Y. Curb	*4	*4	*4	Mar., 1923	0.05
Yukon Gold	Boston Curb	*50	*50	*50	June, 1918	0.02
SILVER						
Beaver Consol	Toronto	1.51	1.40	1.40	May, 1920	0.03
Castle-Trethewey	Toronto	*57	*56½	*57		
Coniagas	Toronto	5.45	5.45	5.45	May, 1924	0.12½
Keeley	Toronto	*54	*50	*52	Ma.1, Ma.15 SA	0.04
Lorrain Trout Lake	Toronto			*30	July, 1925	0.05
Mining Corp. Can	Toronto	3.40	3.25	3.40	Ja.10, Ja.25 SA	0.125
Nipissing	N. Y. Curb	4⅛	4	4⅛	Ma.31, Ap.20Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	4⅜	4	4¼	Ap., 1927	0.12½
Bingham Mines	Boston	48⅜	48⅛	48⅛	Ma.22, Ap.5 Q	1.00
Bunker Hill & Sullivan	N. Y. Curb	139¾	135½	139¾	Ap.30, My.4 MX	0.75
Cardiff M. & M	Salt Lake	*75	*73	*75	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	4.22½	4.12½	4.12½	Ja.10, Fe.1 Q	0.10
Consti'n Mng.&Mill'g	Spokane	*15	*10	*15		
Erupcion	Boston Curb			*30	Ap. Q	0.07½
Eureka Lily	Salt Lake	2.02½	1.85	1.85		
Federal M. & S	New York	120	120	120	Je., 1927	10.00
Federal M. & S. pfd	New York	95	95	95	Fe.24, Ma.15 Q	1.75
Hecla Mining	N. Y. Curb	13⅜	13	13½	My.15, Jn.15 Q	0.15
Highland-Surprise	Spokane	*12½	*11½	*12½		
Iron King Mining	Salt Lake	*65	*63	*64		
Keystone Mining	Salt Lake	*32	*32	*32	Fe., 1926	0.07½
Lucky Jim	Spokane	*39	*34	*36		
Lucky Tiger-Com	Kansas City	†7.75	†7.50		Ap.10, Ap.20MX	0.07
Mammoth Mining	Salt Lake	†2.00	†1.50		De., 1926	0. 25
North Lily	Salt Lake	6.55	6.40	6.55		
Park Utah	New York	11⅛	10⅛	10⅞	Ma.15, Ap.15 Q	0.20
Plutus Mining	Salt Lake	2.00	2.00		Ap.10, Ap.16	0.10
Silver King Coal	Salt Lake	11.25	11.12½	11.25	Ma.20, Ap.2 Q	0.25
Silversmith	Spokane	*17½	*17	*17½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*46½	*45	*46½		
Sunshine M. Co	Spokane	1.40	1.35	1.38	Fe.10, Fe.20	0.10
Tamarack-Custer	Spokane	*91	*85	*90	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.50	13.25	13.25	Ma.21, Ma.29Q	0.30
Utah-Apex	Boston	4⅛	4 1/16	4 1/16	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	62⅛	61	61½	Jy., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	119	114	115	Ap.13, Ap. 25. Q	1.00
Colorado Fuel & Iron	New York	74¾	71⅛	74	May, 1921	0.75
Gt. North'n Iron Ore	New York	23½	22½	23½	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	56	54½	56	My. 15, Jn. 1 Q	0.62½
Republic I. & S	New York	60⅜	59½	59⅜	My. 15, Jn. 1 Q	1.00
Republic I. & S. pfd	New York	108½	108	108	Jn. 15, Jy. 2 Q	1.75
Sloss-Sheffield S. & I	New York	121½	121½	121⅜	Ma. 10, Ma. 20 Q	1.50
Sloss-Snef. S.&I. pfd	New York			122½	Ma. 20, Ap. 2 Q	1.75
U. S. Steel	New York	146⅞	143⅜	145⅜	My.31, Jn.29 Q	1.75
U. S. Steel, pfd	New York	147½	146⅜	147½	Ap. 30, My. 29 Q	1.75
Virginia I. C. & C	New York	32	31¼	31⅞	Jan., 1924	1.50
Virginia I.C.&C. pfd	New York	56	56	56	De. 16, Ja. 3 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	26½	26½	26½	Jy., 1927	1.45
So. Am. G. & P. New	N. Y. Curb	3½	3	3½		
Alum. Co. of Amer	N. Y. Curb	149½	141	146		
Alum. Co. of Amer. pf.	N. Y. Curb	109½	109¼	109½	Ma. 15, Ap. 1 Q	1.50
Vanadium Corp	New York	83½	79¼	83	My. 1, My. 15 Q	0.75
Patino M. & E	New York	41	30⅜	41	April, 1928	4s.
ASBESTOS						
Asbestos Corp	Montreal	36	32	35	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	93½	92¼	93	Ma. 31, Ap. 16 Q	1.75
SULPHUR						
Freeport Texas	New York	81⅜	72	80½	Ap.14, Ma.1 QX	1.75
Texas Gulf	New York	74⅜	71⅛	74⅛	Ma. 1, Ma. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	45⅛	42⅛	44½	My.15, Jn.1	0.75
Amer. Metal, pfd. 6%	New York	115	113⅜	115	My.15, Jn.1	1.50
Amer. Met. pfd. 7%	New York	125½	125	125⅛	My.15, Jn.1	1.75
Amer. Sm. & Ref	New York	188½	182½	187½	Ap.13, My.1 Q	2.00
Amer. Sm. & Ref. pfd	New York	141½	141	141⅛	My. 4, Jn. 1 Q	1.75
Consol. M. & S	Montreal	271½	267⅞	271½	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	1⅛	*90	1	Ma.31, Ap.16 Q	1.00
U. S. Sm. R. & M	New York	42⅞	41	42⅞	Ap.5, Ap.14 Q	0.87½
U.S. Sm. R.&M. pfd	New York	53⅛	53	53	Ap.5, Ap.14 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. K, irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED APRIL 17, 1928 Last Div.

Name	High	Low	Last	Date	Amount
Aramayo Mines (25 frs.)	67/6	65/7½	66/3	Feb., 1928	5 p.c. (†)
Burma Corpn. (10 rupees)	13/—	12/4½	12/10½	Jan., 1928	6 annas*
Bwana M'Kubwa (5s)	5/4½	5/9	5/—		
Camp Bird (2s)	5/—	4/9	4/8	April, 1928	16⅔ p.c.
El Oro (£1)	4/6	4/1½	4/6	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	14/6	13/9	14/—	Jan., 1928	5 p.c.
Mexican Corpn. (£1)	9/9	9/4½	9/9		
Mexico Mines of El Oro (£1)	27/6	23/9	26/3	Dec., 1926	3¾ p.c.*
Mond Nickel	161/10	150/—	155/—	Feb., 1928	7½ p.c.
N'Changa Copper Mining	11/9	11/3	11/6		
Oroville Dredging (£1)	4/—	3/9	4/—	Dec., 1923	3¾ p.c.
Rhodesian Congo Border (£1)	24/4½	17/6	22/6		
St. John del Rey (£1)	12/9	12/4½	12/9	May, 1927	3½ p.c.
San Francisco Mines (10s)	28/1½	27/6	27/9	Jan., 1928	25s.
Santa Gertrudis (£1)	15/7½	14/9	15/—	Jan., 1928	7½ p.c.
Selukwe (2s. 6d.)	13/9	11/4½	11/10½	April, 1928	6¾ p.c.
S. Amer. Copper (2s.)	2/4½	2/—	2/1½	Nov., 1917	75 p.c.
Tanganyika (£1)	66/6	62/6	63/1½	Aug., 1927	7½ p.c.
Union Miniere de Haut-Katanga (Brussels)	8,487.50	8,225	8,225	July, 1927	182.60 (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation.